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When Switch Cabinets Are Used as Lockers

A Danger Trap Is Set That in Time Will Catch the Offender or Some Maintenance Inspector

HERE'S a photograph I took on a recent inspection trip that shows a practice more widespread than is commonly supposed. When enclosures like this one are used as a catch-all for lunch baskets, clothing, tools, oily gloves and the like, a danger trap is set that sometime or other will catch the offender or the inspector who must maintain the equipment. I hate to preach about a practice like this in a critical way, but I feel that the importance of the danger justifies placing the blame squarely up to the guilty individual. If he does not know the serious results that may occur he can be excused once, but if he does know the danger trap he sets and continues the practice a discharge without discussion is the proper penalty.

In the plant where this photograph was taken almost everything possible has been done to provide safety and protection for operators and workmen. Gears, belts and chains are enclosed with safety guards. There is no open wiring, with good use being made of rigid and flexible conduit. Safety stops are provided where necessary. Tools and materials in process have their proper places so that the workman is not likely to collide with, or fall over, them while at work.

Very liberal use has been made of safety switches, push-button control switches and of enclosures for distribution and control cabinets. The cabinet which is illustrated encloses the generator control panel of an arc welding set. This installation represents unusually good practice. The motor-generator and the stabilizer are mounted on a steel table which is about waist high, so as to make the apparatus convenient for inspection and maintenance. The starter near the motor is enclosed and controlled by a conveniently located push button. The stabilizer or reactance is totally enclosed with grillwork.

It is evident that the operating management has provided a safe installation for the workmen and for those who are called upon to maintain this equipment. The man who used this control cabinet as a locker, however, defeated in a serious way the safety elements that the installation provided.

Seemingly this practice is very difficult to control. Supervisors of safety installations all unite in condemning it, yet it continues. In one plant this evil has been effectively combated by placing padlocks on all enclosures and giving keys only to inspectors who are responsible for the operation or maintenance of the equipment enclosed. This is one definite way of locating an individual who either has a total disregard for the need of safety or carelessly ignores the safety practices that are now so commonly provided. Since safety work depends as largely upon the individual as upon the method, a careless individual is just as serious a hazard to his fellow workmen as the device which needs protection.

If any of our readers have found a way of stopping this practice of using safety enclosures for lockers we should be glad to know the way they have gone about it.

Practical Pete

A Glimpse Into the

Works of The Shredded Wheat Company

Where 6,000 bushels of wheat are daily put through a special cooking, shredding and baking process which transforms it into a delicious cereal food. An open-house policy to guests attracts over 100,000 visitors every year.

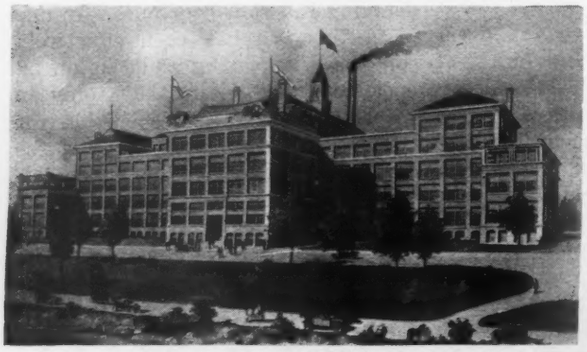
ONE of the big problems of all food-products plants is to maintain a high degree of cleanliness, both of equipment and surroundings. The factories of The Shredded Wheat Company are planned to help make this easy. For example, plenty of light is one of the best antidotes for poor housekeeping. Therefore, the walls of the building are constructed with large window areas which eliminate dark corners. Concrete floors add to the ease with which the force of janitors maintains good housekeeping.

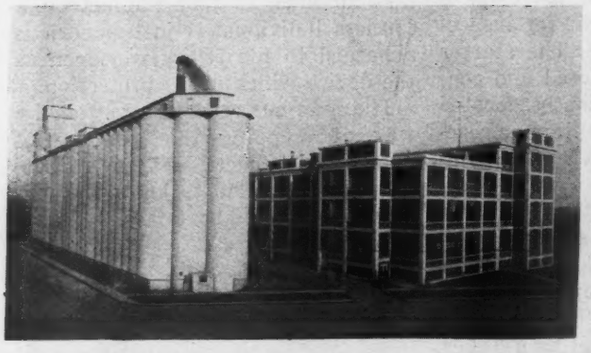
Three of the rows of packing tables each with a double file of girls.

Because of the fragile nature of the product, the biscuits must be inserted into the cartons by hand. The filled boxes are carried by conveyor to a sealing machine which closes both ends and seals them up so that the carton is practically moisture and air tight.

In addition, much attention is given to the personnel, for even with bright and cheerful surroundings, the actual keeping of the factory and product clean depends upon the care of the workers. Therefore, welfare work is carried on extensively. In addition to a visiting nurse, a dispensary in charge of a trained nurse, individual lockers, rest rooms and lunch rooms (which are free to the women workers), opportunity is given to the workers for bathing and otherwise encouraging cleanliness and neatness. A large auditorium, capable of seating 1,000 persons, is used from time to time for lectures and other entertainments as well as dances and parties.

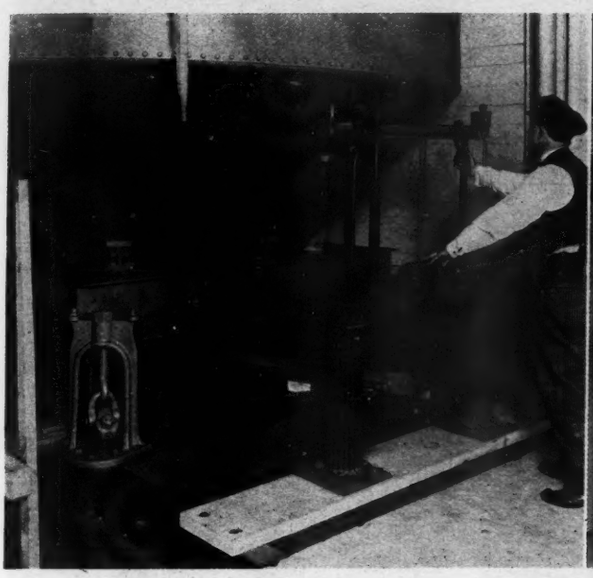
About thirty years ago Mr. Perky developed the idea of making from the whole of the wheat, a cereal which could be baked in a biscuit and would keep indefinitely. An attractive location on the banks of the Niagara River within a short distance of the American Falls was chosen for the factory which was erected in 1901. The main factory is five stories high, 463 ft. long by 66 ft. in depth with four side extensions and contains 276,586 square feet of floor space devoted to office and manufacturing purposes. Natural lighting is supplied by 884 windows with 30,000 lights of glass, which alone offer a big problem in the necessary replacements and in keeping them clean. Additional fac-

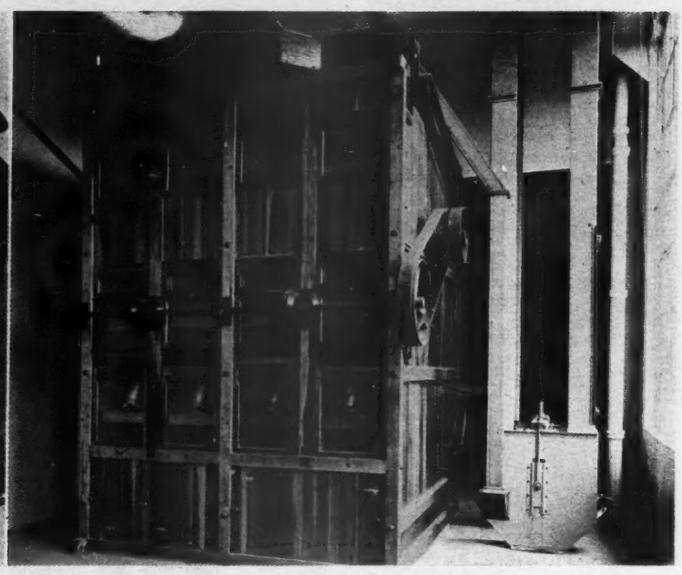




Here are three of the four plants of The Shredded Wheat Company.

The two plants shown at the left are at Niagara Falls, N. Y. The plant at the top is the main factory and is built within sight of the American Falls. The plant below at the left is built a few blocks away, with a large wheat storage tank having a capacity of 750,000 bushels. Elaborate dust collectors which have been made as the result of a number of years of experimental work are installed with this. Over 1,800 tons of dust and defective grain as well as weed seeds are removed from the wheat each year in the cleaning process. The plant below is located at Oakland, California.





tories are located at Oakland, Calif., Niagara Falls, Canada, and a second factory at Niagara Falls, N. Y. All are quite similar in that they have large window area.

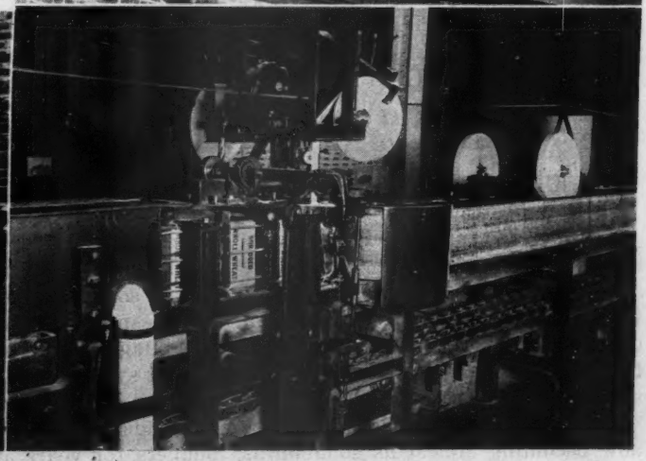
Before the wheat is ready to be prepared for shredding, it passes through twenty-two cleaning machines which remove all dust, weed seeds, straw and other foreign substances as well as shrunken, broken and defective grains. About 1,800 tons of this unusable material are removed annually in this cleaning process. The cleaned wheat then goes to large cylindrical tanks where it is cooked, meanwhile being agitated by revolving steel paddles. This treatment breaks up the starch granules in the center of the wheat kernel and renders them soluble and digestible. The outer coat of the grain of wheat is unbroken; so none of the nutritious elements in the wheat are lost in the process of cooking. The grain is then passed through a cooling and conditioning machine to remove any excess moisture which might interfere with the next operation of shredding. The conditioned wheat is fed into the hoppers of the shredding machines which are 88 ft. long and contain thirty-six pairs of steel rolls. These deposit the layers of shredded grain *(Continued on page 325)*

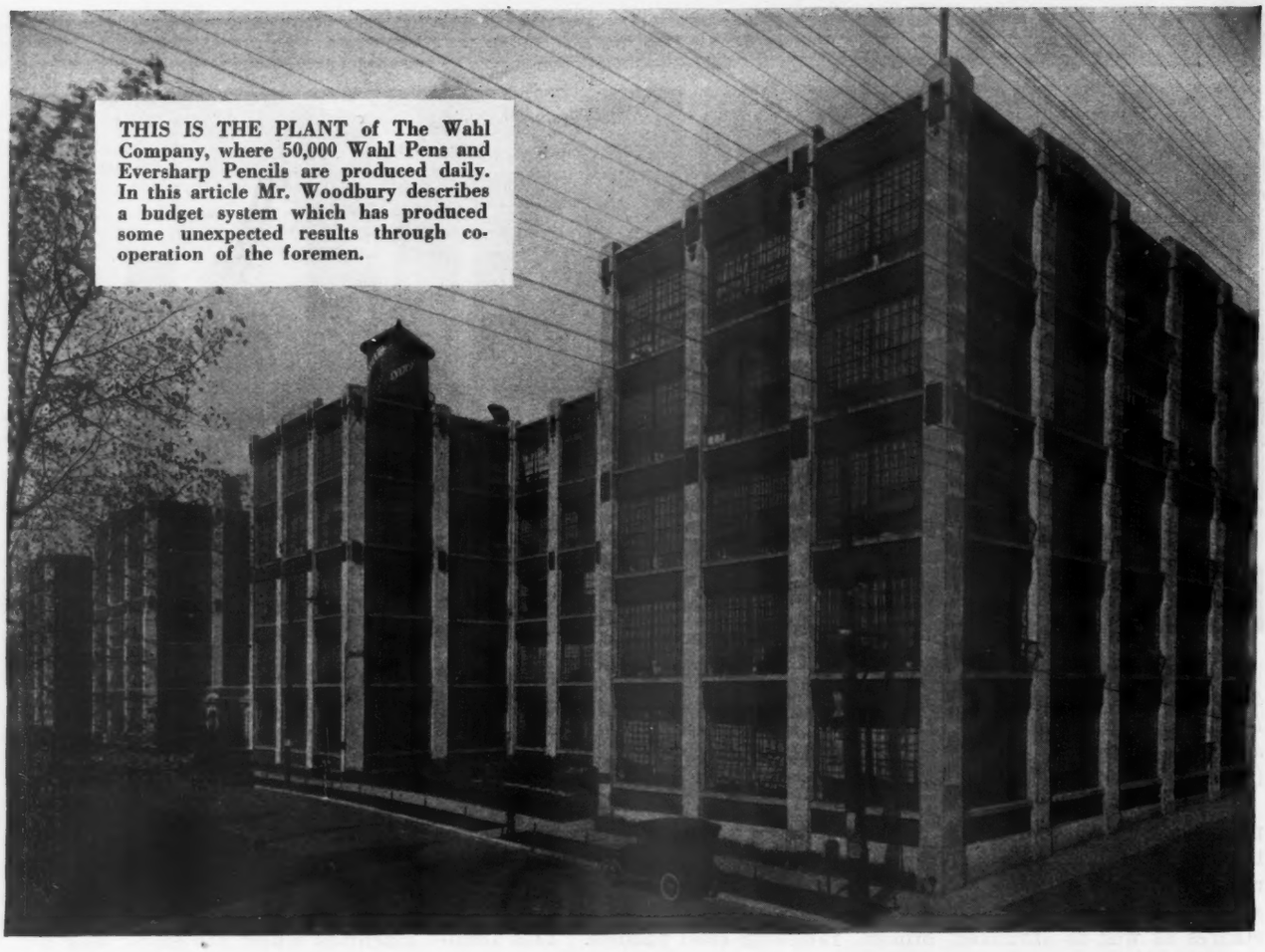
Weighing and cleaning the wheat.

All wheat is first weighed. The wheat is then passed through twenty-two cleaning machines which remove all the dust, dirt, weed seed, shrunken and imperfect grains and any foreign material which might damage the rolls. Altogether, 1,800 tons of this material are removed during the year.

These illustrations show three steps in the making and packing of the shredded biscuit.

After passing under the thirty-six shredding machines, the layers of shreds are carried on a chain conveyor to the machine below which forms the biscuits and puts them on pans containing fifty-two. These pans are placed on the truck to be carried on to the oven shown at the right. The biscuits go through two sets of ovens and are baked and crisped and then are taken to the packing room shown at the heading of this article. The filled cartons are carried by conveyor from the packing tables to this special sealing machine, which not only seals up both ends of the box but also dries the vegetable glue immediately.





THIS IS THE PLANT of The Wahl Company, where 50,000 Wahl Pens and Eversharp Pencils are produced daily. In this article Mr. Woodbury describes a budget system which has produced some unexpected results through co-operation of the foremen.

Things That Can Be Accomplished by

Budgeting Repair and Maintenance Expenses

And the Details of a Plan Which Has Been in Operation for Two Years in the Plant That Makes Wahl Pens and Eversharp Pencils

By W. F. WOODBURY

Comptroller, The Wahl Company, Chicago, Ill.

IN THIS ARTICLE Mr. Woodbury points out that after two years' experience with the budget system for maintenance and repair work at the plant of The Wahl Company, the following advantages have been apparent: (1) Maintenance and repair costs can be closely estimated and controlled. (2) An accurate record is provided of the quantity and quality of the work of the Maintenance Department. (3) The foremen of the various departments have been led, by their desire to make a good showing in their departments, to take a deep interest in maintenance work and thus assist the maintenance department in many ways. (4) An incidental result has been the cutting down of power, heat, light and other like expenses, through prevention of waste. Performance of unnecessary maintenance or repair work is avoided. (5) A definite relation is maintained between production and maintenance work. (6) Although the budgets are made up a year in advance, provision is made for increasing or reducing the figures as necessary.

DURING the past two or three years the word "budgeting" or the term "budgetary control" has become so common that we are sometimes inclined to smile when we hear them used loosely and wonder if the person who is doing the talking really appreciates the true significance of the topic.

References to "budgeting" are now becoming almost as common as references to "efficiency" and if we are not careful, the former subject is liable to be just as much overworked as the latter. At the same time we must remember that the actual application of budgets to industrial works is in its infancy, although in some of the older organizations it has been in use many years. For instance some of the European countries, especially Great Britain, have had budgets and have operated with budget systems for many years, with more or less good results. Our own railroads have operated on practical budgets for years and it is probably owing to that fact that they have perhaps got more for their dollar than the average industrial works, although some of the larger organizations of the industrial class have,

especially during the past few years, been keyed up to a high state of efficiency.

Budgeting or budgetary control has more recently been adopted to a more or less extensive degree by considerable numbers of industrial organizations, both large and small. In fact many firms who really control their activities through budgets in one form or another would not even admit it.

Budgeting, like many other things, is good only if followed up—it is of absolutely no use whatsoever to set standards (because that is what budgeting is) if the standards set are not aimed at, and a checkup of the hits recorded and followed up closely.

In general, budgeting will vary considerably according to the size of the organization—in fact in a small one-man organization it may not even be necessary as most of the responsibilities are carried on the shoulders of one or two men who have the vital items of the business at their fingertips.

However, industry is getting away from the one-man organizations and tending more and more to amalgamations and larger concerns with great resources. Between these two extremes there are multitudes of firms of small, medium and large-sized organizations which need a budget or budgetary control to handle their business successfully. The matter of budgeting, while at times somewhat difficult of application, is of paramount importance.

All classes of overhead operations, from administrative and selling expenses to manufacturing and maintenance expenses, can be and should be budgeted. These and other expense budgets must be predicated on sales. Perhaps the hardest section of all to budget, and the one which will be considered in this article, is the repair and maintenance expense section, as there are so many phases and angles to consider.

In fact the matter of repair and maintenance is so comprehensive that it touches the entire organization and is of such vital importance to a concern of any size that the services of an expert engineer are not only advisable but necessary.

The equipment of a modern, large or fairly large plant is usually of such an intricate, often delicate nature, that to entrust the upkeep to anyone but an expert is laying up trouble. Further, so much can be done in the matter of heat, light and power costs that an experienced engineer with the aid of a budget can save large sums for a company. As a matter of fact, the making up of the budget depends to a large extent upon the power and other charts and records which are kept by the maintenance engineer.

In installing a budget system in The Wahl Company we realized that one of the hardest, if not the hardest item to budget was the one of repair and maintenance charges.

This can be realized from the fact that our factory contains 210,000 sq. ft. of floor space and is divided into forty departments. For producing an output of 50,000 pens and pencils daily there are employed many hundreds of machines of various types, ranging from small precision lathes to large rolling mills in which the ingots of gold, silver and other metals from which the pen and pencil bodies are formed, are rolled down preparatory to being drawn into tubes. Figs. 6, 7 and 8 show some of the types of equipment employed. A total of 233 electric motors, with an aggregate rating of 1,500 hp. is required to drive all of this equipment. Of these motors 140 are three phase, and 93 are single phase; they operate at 440 volts, and range in size

Fig. 1—Report form for weekly inspection of buildings and fire-fighting equipment.

The Wahl Co.

Fire Protection Report.

This Report must be Filed every Saturday Date.....

Sprinkler.....	Condition of fire extinguisher basement.....
Condition of Pumps.....	Condition of fire extinguisher 1st floor.....
Pounds pressure-1st section ( )lbs.....	Condition of fire extinguisher 2nd floor.....
Pounds pressure-2nd section ( )lbs.....	Condition of fire extinguisher 3rd floor.....
Pump switch on auto or hand control.....	Condition of fire extinguisher 4th floor.....
Amount of water in tank.....ft.	Condition of fire extinguisher 5th floor.....
Condition of tanks.....	Condition of water pails & barrels 1st floor.....
Lowest temperature of water in tanks.....	Condition of water pails & barrels 2nd floor.....
Lowest temperature in pent house.....	Condition of water pails & barrels 3rd floor.....
Condition of fire hose basement.....	Condition of water pails & barrels 4th floor.....
Stand pipe West.....	Condition of water pails & barrels 5th floor.....
Stand pipe East.....	Condition of tarpaulin.....
Valve at pump.....	Condition of entrance to stairs.....
Valve at pit.....	Condition of fire doors to stairs.....
Valve at tank.....	Condition of fire escapes.....
Drain valve.....	Condition of fire escape doors.....
Drain Valve.....	Condition of exits to streets.....
Valve No. 7 - open or closed.....	Condition of aisles to sprinkler risers.....
Valve No. 8 - open or closed.....	Condition of paper baling room.....
Condition steamer connections.....	Condition of bottom of elevator shafts.....
Are all sprinkler valves sealed?.....	Oily waste cans empty.....
	Inspected by.....
	O K'd by.....

Remarks:

.....

.....

.....

.....

FORM 1100

REQUEST FOR BUDGET CHANGE

Comptroller,

Please revise yearly budget for Department No.____ Name _____

Change acct. No.____ Name _____ From $____ To $____

Change acct. No.____ Name _____ From $____ To $____

Reasons for Changes

Original Department Budget $____

Revised Department Budget $____

Increase or Decrease $____

Signed, _____

Signed, _____ DIV. HEAD

Approved, _____ GEN. MANAGER

Fig. 3—When conditions make it necessary to change the budget for any department this form is filled out.

This is made out in duplicate and the approval of the division head and of the general manager must be obtained before the budget may be changed. The original of the form goes to the comptroller's files, while the second copy is sent to the division head.

from 1/8 hp. to about 200 hp. rating.

We have a well-organized system of equipment and building inspection and maintenance, which is carried out under the direction of the maintenance engineer. Without going into all of the details it may be said that the maintenance schedule calls for weekly inspection of all motor and control equipment, and the like.

Also the maintenance engineer renders a weekly Fire Protection Report showing the condition of the sprinkler system, pumps, valves, fire extinguishers, escapes, doors, exits, etc., as detailed in Fig. 1.

In addition, the maintenance engineer makes periodical peak load and departmental motor load tests to make sure that the equipment is properly loaded and that no unusual conditions have developed. No additional machinery is added to any department without first consulting the engineer's records to ascertain if the present motor equipment will take care of the added capacity. Likewise, charts are kept on the consumption of electrical energy, gas, coal, oil and so forth.

Fig. 2—Foreman's report sheet, which is given out every month and shows the charges made against each department.

These reports are sent to all department foremen and have been of much value in fostering close co-operation between the foremen and the maintenance department, and reducing power, heat and light costs by prevention of waste.

NO. 1040

THE WAH[illegible] COMPANY

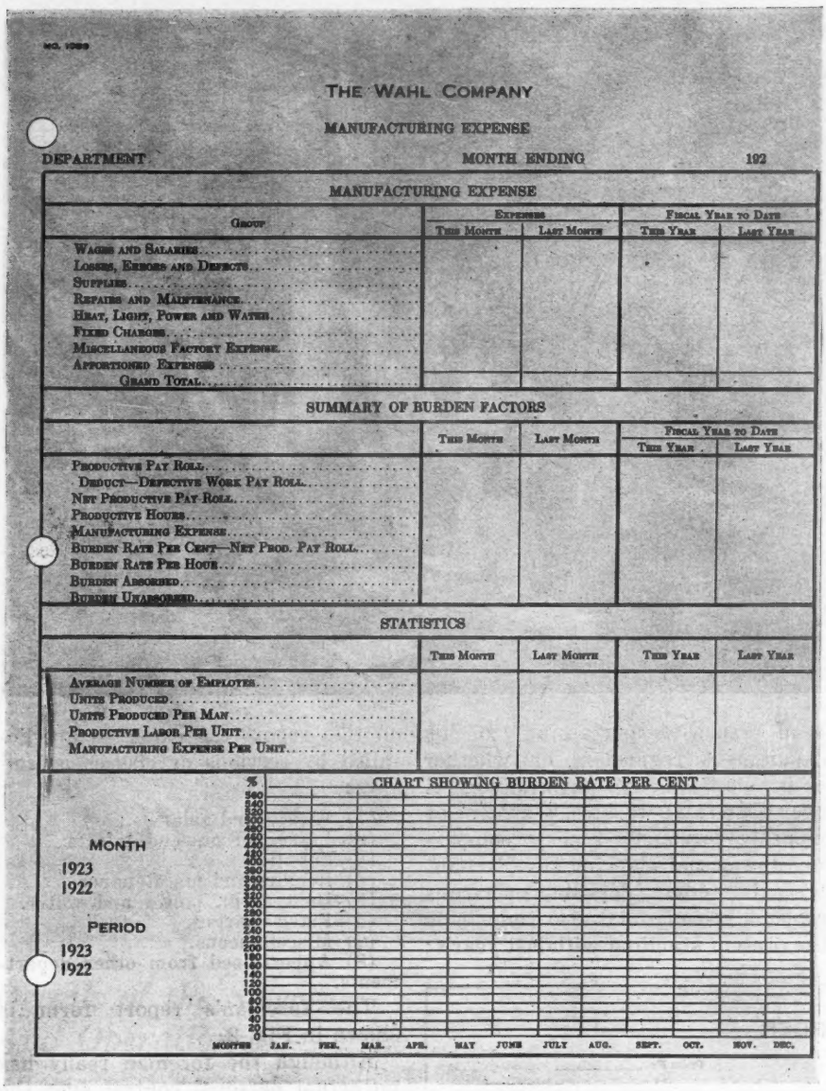
ANALYSIS AND COMPARISON OF DEPARTMENTAL EXPENSES

MANUFACTURING DEPARTMENTS

DEPARTMENT PERIOD

Acct. No.	Account	Actual Amount	Estimated Amount	Over or Under Estimate	Same Period Last Year
450	Foremen and Assistants				
451	Clerks and Messengers				
452	Timekeepers				
454	Timestudy and Ratesetting				
455	Production Clerks, Storekeepers, etc.				
456	General Inspection				
457	Engineering & Experimental				
458	Cleaners, Oilers & Janitors				
459	Watchmen & Elevator Opers.				
460	Matrons and Nurses				
462	Student Labor				
463	Folding Circ. & Filling Cart's				
464	Rearrangement, Mchy., Labor				
465	Sundry Labor				
466	Tool and Die Setting				
467	Unapplied Productive Labor				
	Total Wages and Salaries				
480	Defective Workmanship				
481	Sick, Injured & Absent Emp.				
482	Waiting Orders, Stock, etc.				
483	Overtime Excess & Allces.				
484	Pencils, Pens & Sundries Lost				
485	Reconditioning Scrap for Sale				
486	Def. Mat'l Not Ret'd to Sup'r				
487	Change in Design				
488	Reconditioning Finished Stock				
	Total Losses, Errors & Defects				
490	Stationery & Office Supplies				
491	Cutting Oils, Cleaning Rags, etc.				
492	General Supplies				
493	Plating, Buff. & Polish Sup's				
494	Janitor's Supplies				
495	Medical Supplies				
496	Experimental Supp. & Mat'l				
497	Rearrangement Mchy., Lbr.				
498	Boxing, Wrapping & Packing				
	Total Supplies				

Acct. No.	Account	Actual Amount	Estimated Amount	Over or Under Estimate	Same Period Last Year
	REPAIRS & MAINTENANCE				
500	Buildings and Grounds				
501	Mchy., Power, Tools & Appli.				
502	Shop Equipment				
509	Reps. to & New Loose & Hand Tools				
510	Patts., Dies, Jigs & Temp.				
511	Furniture & Fixtures				
	Total Reps. & Maintenance				
	HEAT, LIGHT, POWER AND WATER				
540	Fire Insurance				
541	Liability Insurance				
542	Taxes, Real Est. and Personal Depreciation of				
543	Buildings				
544	Mchy., Power Tools & Appli.				
545	Shop Equipment				
546	Patts., Dies, Jigs & Temp.				
547	Furniture and Fixtures				
	Total Fixed Charges				
560	Traveling and Entertaining				
561	Telephone and Telegraph				
562	Gratis Pens, Pencils & Sund.				
563	Expense Taking Inventories				
564	Fgt., Express & P.-Post Unapp.				
565	Meals for Employees				
566	Laundry				
567	Sundries				
568	Subs, Membership & Dues				
	Total Misc. Factory Exp.				
	Total Direct Dept. Expense				
	Apportioned Charges				
	Grand Total Dept. Expense				



THE WAHL COMPANY

MANUFACTURING EXPENSE

DEPARTMENT MONTH ENDING 192

MANUFACTURING EXPENSE

Group	Expenses: This Month	Expenses: Last Month	Fiscal Year to Date: This Year	Fiscal Year to Date: Last Year
Wages and Salaries				
Losses, Errors and Defects				
Supplies				
Repairs and Maintenance				
Heat, Light, Power and Water				
Fixed Charges				
Miscellaneous Factory Expense				
Apportioned Expenses				
Grand Total				

SUMMARY OF BURDEN FACTORS

	This Month	Last Month	Fiscal Year to Date: This Year	Fiscal Year to Date: Last Year
Productive Pay Roll				
Deduct—Defective Work Pay Roll				
Net Productive Pay Roll				
Productive Hours				
Manufacturing Expense				
Burden Rate Per Cent—Net Prod. Pay Roll				
Burden Rate Per Hour				
Burden Absorbed				
Burden Unabsorbed				

STATISTICS

	This Month	Last Month	This Year	Last Year
Average Number of Employes				
Units Produced				
Units Produced Per Man				
Productive Labor Per Unit				
Manufacturing Expense Per Unit				

CHART SHOWING BURDEN RATE PER CENT

MONTH
1923
1922

PERIOD
1923
1922

% 360 340 320 300 280 260 240 220 200 180 160 140 120 100 80 60 40 20 0

MONTHS JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.

Fig. 4—Recapitulation of manufacturing expenses, burden factors and statistics.

This sheet is made out monthly and goes to the factory executives and general management.

We are convinced that keeping a plant clean, sanitary and well-ordered saves money in the long run and we make provision for periodical general house-cleaning and painting, in addition to the usual janitor service.

We know that in order to produce a given output, a certain number of motors and other equipment will have to be operated. Consequently, the budget is predicated on estimated sales, taken in conjunction with past experience, and in estimating or budgeting the maintenance expenses, the accounting records which we have and the charts which are kept by our maintenance engineer are of inestimable value. From these charts we are able to budget a year ahead and set up the figures for monthly allowances. The monthly budgets for general maintenance work are, of course, subject to change as the year progresses, inasmuch as our records may show that owing to increases or decreases in sales and production it is necessary to adjust our overhead expenses.

On the other hand, some parts of our maintenance can be handled more accurately and with much less difficulty than others. For instance, the cost of cleaning and painting can be estimated very closely and a certain specified allowance set aside to cover these items during the year.

As will be seen from the Foreman's Report, Fig. 2, which will be referred to later, each of the various items that come under the head of maintenance and repairs is given an account number.

The estimated cost of doing the work represented by each account number is then determined. As the maintenance and repair labor and material tickets are turned in, they are charged against the proper account number.

The maintenance budgets as well as all the other budgets of the organization require the approval of the general manager and reports are rendered to him monthly both summarizing and detailing the expenses of the organization by totals, by classes of expenses and by departments, in such a manner that overruns and deficiencies are readily brought to his attention. Among these reports is a recapitulation of manufacturing expenses, burden factors and so on, shown in Fig. 4.

As this is only our second year of

Fig. 5—Punch presses and other heavy equipment likewise enter into the manufacture of pens and pencils.

Fig. 6—Part of the pen assembly and machining department.
The equipment in this department is light and consists for the most part of precision lathes and fine grinding devices.

operation under a budget system, it will be realized that it is as yet far from perfected, but already we are seeing extensive benefits. Incidentally, the budgeting of operating expenses in general has had a bearing in itself in keeping the repair and maintenance charges down, for a foreman realizes that if he allows his machinery to run down, subsequent breakdowns cost his department money. Consequently, notwithstanding the fact that, as mentioned before, our maintenance engineer has a very thorough, systematic inspection layout, is continually making motor and other tests, and keeps running charts on the consumption of gas, oil, coal and so on, he now has allies in all the foremen in the matter of keeping down maintenance costs.

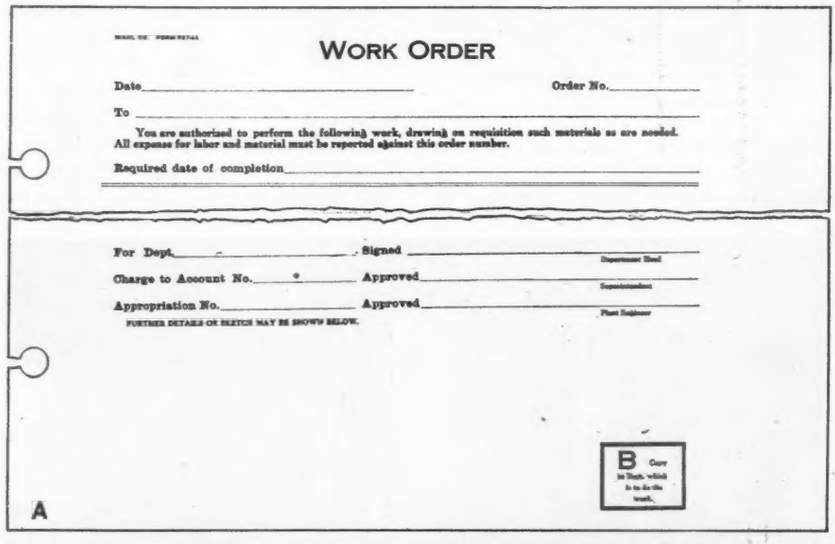
The matter of foreman's reports has been discussed at length by many accountants and accounting organizations and there are many differences of opinion as to just how much information should be supplied to the foreman. We believe in giving the foreman a report of the overhead expenses pertaining to his department regardless of whether or not he has actual physical control over them and we have a system of monthly foreman's reports comparing the actual showing by account with the budget, detailing over-runs and under-runs, and also comparing the present standing with last year's; on this report the expenses are detailed by sections or classes as follows:

(1) Wages and salaries.
(2) Losses, errors and defects.
(3) Supplies.
(4) Repairs and maintenance.
(5) Heat, light, power and water.
(6) Fixed charges.
(7) Miscellaneous.
(8) Apportioned from other departments.

The foreman's report form is shown in Fig. 2.

Although the foreman really has no actual personal control over the Repairs and Maintenance section, or at least not wholly so, or over the Heat, Light and Power section, we have found that by suggestions from the foreman and by check-ups made by him we have been able to realize savings which would not have been possible otherwise. The interest which the foremen take in these reports is remarkable, and they have paid for themselves many times over.

With our series of reports we are able to keep a close check against the budgets and *(Continued on page 354)*



WORK ORDER

Date _____ Order No. _____

To _____

You are authorized to perform the following work, drawing on requisition such materials as are needed. All expense for labor and material must be reported against this order number.

Required date of completion _____

For Dept. _____ Signed _____
Department Head

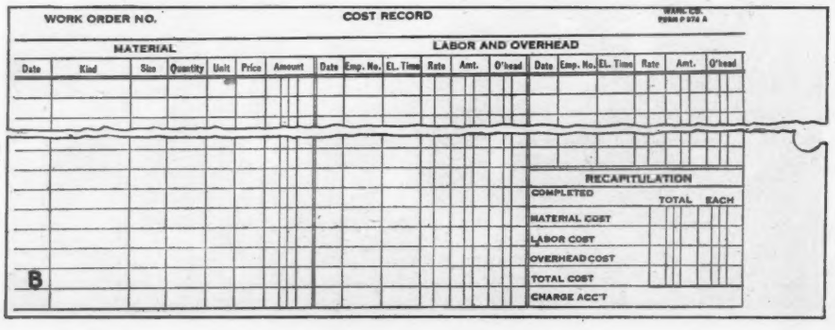
Charge to Account No. _____ Approved _____
Superintendent

Appropriation No. _____ Approved _____
Plant Engineer

FURTHER DETAILS OR SKETCH MAY BE SHOWN BELOW.

B Copy in Dept. which is to do the work.

A



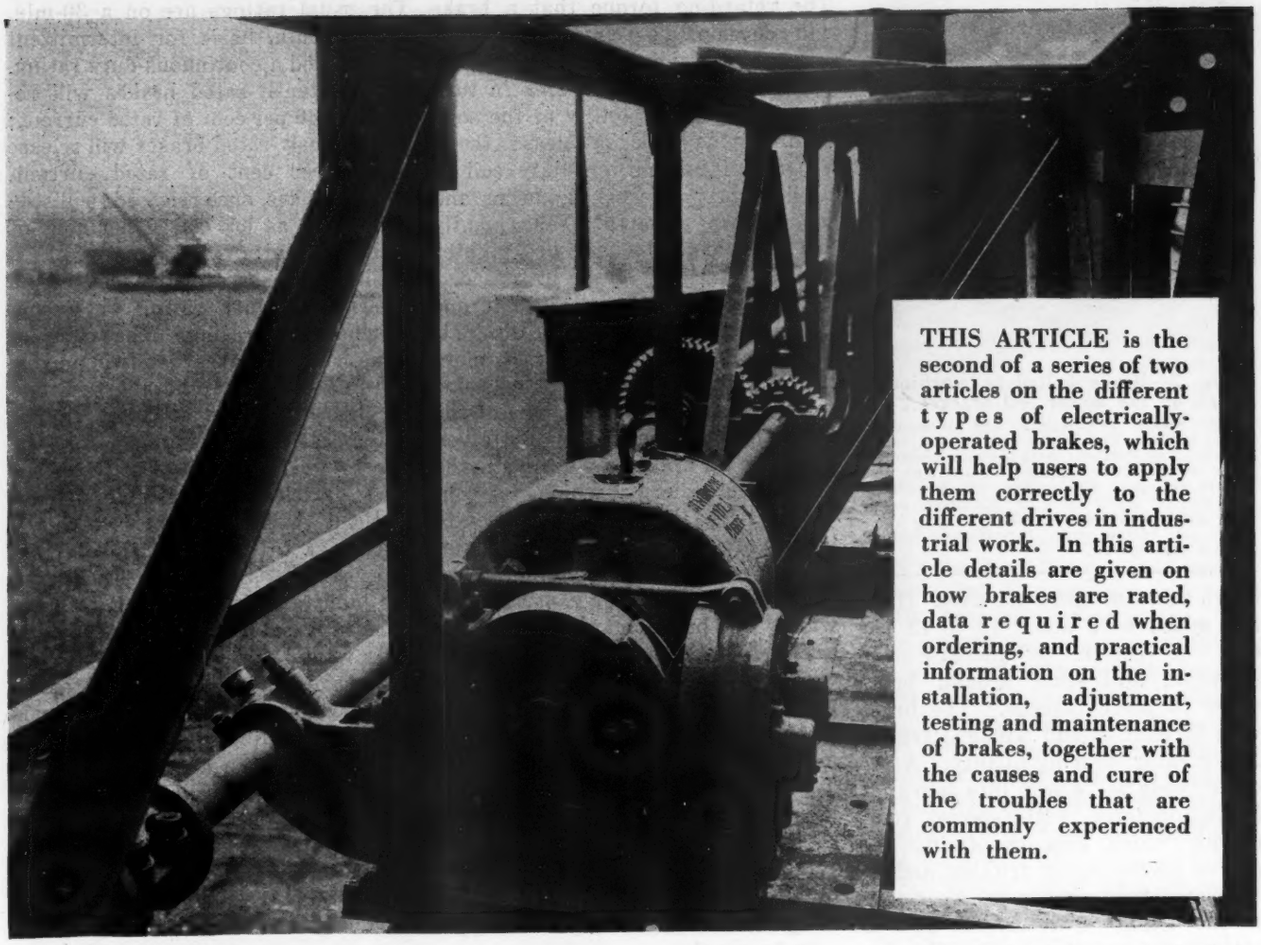
WORK ORDER NO. COST RECORD

MATERIAL							LABOR AND OVERHEAD											
Date	Kind	Size	Quantity	Unit	Price	Amount	Date	Emp. No.	El. Time	Rate	Amt.	O'head	Date	Emp. No.	El. Time	Rate	Amt.	O'head

RECAPITULATION		
COMPLETED	TOTAL	EACH
MATERIAL COST		
LABOR COST		
OVERHEAD COST		
TOTAL COST		
CHARGE ACC'T		

B

Fig. 7—Before any maintenance work is performed for a department, authorization must be obtained on a form like this.
This form, *A*, is made out in triplicate and covers both maintenance work and additions to plant. On the reverse side, *B*, of the *Accounting Department's* copy, the material and labor for doing the job are posted and then charged to the department for which the work was done. This form is originated by the department head and must be approved by the superintendent and plant engineer. One copy of the order goes to the files of the department which originates the order; the second copy goes to the department for which the work is being done and the third copy is filed in the *Accounting Department.*



THIS ARTICLE is the second of a series of two articles on the different types of electrically-operated brakes, which will help users to apply them correctly to the different drives in industrial work. In this article details are given on how brakes are rated, data required when ordering, and practical information on the installation, adjustment, testing and maintenance of brakes, together with the causes and cure of the troubles that are commonly experienced with them.

Fig. 1—Series-wound, direct-current brake operating on the bridge motion of a 20-ton gantry crane. This brake is separately mounted on the bedplate on which the motor is installed. By removing the one pin at the top of the magnet, the rod which connects the magnet to the opposite brake shoe arm may be lifted and the hinged arm swung back to permit the removal of the brake wheel and motor armature. This is done without disturbing in any way the setting of the brake or the alignment between the brake and the motor.

Details of the Selection And Operation of

Brakes Used to Retard Or Hold Rotating Parts

Of Cranes, Hoists, Elevators, Turntables, Lineshafting and the Like to Prevent Overtravel, to Stop at Definite Points, Hold Loads and Make Emergency Stops

By ARTHUR J. WHITCOMB
Associate Editor, Industrial Engineer

A BRAKE is a device for retarding or stopping rotary motion by friction. An electric brake is one which is set by mechanical means and released electrically. In the first article in the June issue, brakes were classified according to mechanical form; that is, as to the mechanical methods of retarding or holding the rotating part. In this same article, brakes were also classified as to their electrical characteristics; that is, according to the method used to release the brakes. In addition, brake wheels, brake bands and brake shoes were discussed. In the following article details concerning the construction and use of brake linings are given together with the rating, selection, testing and operation of electrically-operated brakes.

If steel or iron brake shoes or bands were pressed directly against a steel or iron brake wheel, considerable wear would take place, howling and squealing would result and the friction torque resulting between the two would not be very high. Brake linings are used primarily to secure a higher frictional coefficient and thus obtain more rapid braking. The difficulty lies in finding a material that has a high enough coefficient of friction and at the same time will not burn itself up by the heat generated through the braking action.

Although several kinds of brake linings were mentioned in the preceding article, there is only one kind of lining in common use on electric brakes at the present time. That is the woven asbestos lining, more commonly known by various trade names.

In making woven asbestos brake lining only the highest grade of long,

Fig. 2—Brake bolted to machined lugs on the motor end-bracket.
This makes a compact unit of motor and brake. The brake has two adjustments: adjustment at (1) compensates for wear of the linings; adjustment at (2) changes the value of braking torque or intensity. At the other end of the brake, opposite (1) and (2) are similar adjustments for the opposite shoe and spring.

tough asbestos fibers are used. These are mixed with about 10 to 12 per cent of cotton to increase the strength, and spun around brass wires to make threads. The brass wire is used to add tensile strength and greater wearing quality. After the threads are woven into fabric, it is impregnated with special compounds which give the lining the proper coefficient of friction and at the same time render it impervious to the action of water, oil, grit or other foreign substances. The lining is then baked in ovens, folded in plies to secure the proper thickness, and run through heavy rolls to compress it to the required size.

Carefulness in attaching brake linings cannot be over-emphasized. The rivet heads should be sufficiently countersunk so that they will not bear on the metal drum; the lining should be stretched tight so that there will be no high-spots; and the rivets should be thoroughly upset.

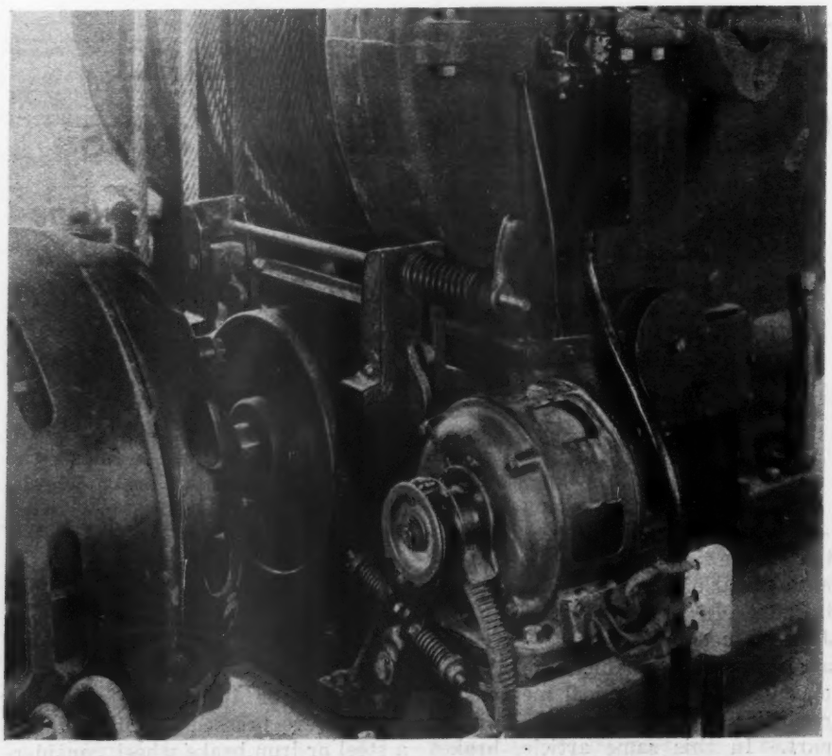
The limiting temperature which most lining materials will stand is about 200 deg. C. Soft fabric lining materials give more friction, but they wear faster and compress. Hard fabric linings do not wear as fast and consequently the brake does not require as frequent adjustment.

Brakes are rated in pounds retarding torque at 1-ft. radius on the brake-wheel shaft. The term "retarding torque" is only applied to a revolving wheel condition. As the coefficient of static friction is higher than the sliding coefficient, the holding torque of a brake, when the wheel is at rest is higher (about 10 per cent) than the retarding torque. The retarding torque that a brake will develop depends upon the amount of weight or the extent the springs are "set up." This in turn depends upon the ability of the solenoid or magnet to release them. Where an intermittent-duty coil is used, it may be worked harder and made more powerful; consequently the brake may be "set up" tighter and its retarding torque increased.

A brake retarding a given torque from a high speed will dissipate more energy (i. e., generate more heat) than one retarding the same torque at a lower speed. One of the limitations on the rating of a given brake is its ability to dissipate the mechanical energy which is converted into heat. Consequently brakes are given a maximum horsepower rating which signifies the highest-horsepower motor with which the brake may be expected, under average conditions, to perform without excessive heating and with reasonable shoe wear.

As the coil of a series brake carries the motor current it must be designed accordingly. Brakes are rated in the same manner as the motors with which they are to be used.

Fig. 3—Motor-operated, alternating-current, shoe brake in service on an elevator.
This brake is fastened directly to the bedplate on which the motor is mounted. As can be seen, the torque motor operating the brake is mounted on the brake frame.



The usual ratings are on a 30-min. or a 60-min. basis for intermittent service and a continuous-duty rating. Intermittently-rated brakes will release on 40 per cent of rated current; continuously-rated brakes will release on 80 per cent of rated current. Series brakes, once released, will stay open with as low as 10 per cent of rated current.

Shunt brakes are given either an intermittent-duty rating or a continuous-duty rating. The coils of some shunt brakes are wound for full-line voltage; others are wound for less than line voltage. In the latter case the coil is put across the line to release the brake; when the brake is released, a resistor is automatically inserted in series with the coil so as to prevent the coil from overheating. Shunt brakes, due to the inductance of the shunt coil, are inherently sluggish in action; using coils wound for less than line voltage makes the brake action faster.

Brakes are selected on the basis of the retarding torque they must develop; also the area of the brake lining must be given consideration. Ordinarily a brake is selected having a retarding torque equal to full-load motor torque. The full-load motor torque may be determined by the following formula:

Torque (in. lb. ft.) $= (5{,}250 \times \text{hp.}) \div \text{r.p.m.}$, where hp. = full-load horsepower rating of motor and r.p.m. = the speed of the brake

wheel in revolutions per minute.

Sometimes a brake with a retarding torque of less than full-load is sufficient, particularly if the brake may be allowed several seconds in which to stop the motor; again, however, a brake with a rating of 150 per cent of full-load torque is selected so as to give a very quick stop, to provide a higher factor of safety, or to hold an occasional heavy load.

When the service to which the brake is to be subjected is unusually severe the heat dissipating ability of the brake becomes the determining factor in its selection. If the horsepower rating of the driving motor exceeds the limiting horsepower rating of the brake (the size of which has been determined by the torque formula), then in order to secure sufficient area of brake lining to insure maximum economy, the brake should be selected on a horsepower basis rather than by the torque rating.

Most shoe brakes are manufactured in sizes up to 400 hp. and 3,200 lb.-ft. torque on the 30-min. rating. Standard lines of disc brakes do not run to such large sizes. In general, the limiting horsepower rating is about 120 hp. and this size will develop a retarding torque of 1,030 lb.-ft. on the 30-min. rating. One manufacturer, however, makes a disc brake with a 250-hp. rating.

The speed of the shaft to which the brake is to be attached should not exceed the maximum safe speed for which the brake is designed. Otherwise a brake-wheel explosion might result with attendant danger to men and equipment.

The manufacturers usually require the following information when brakes are ordered:

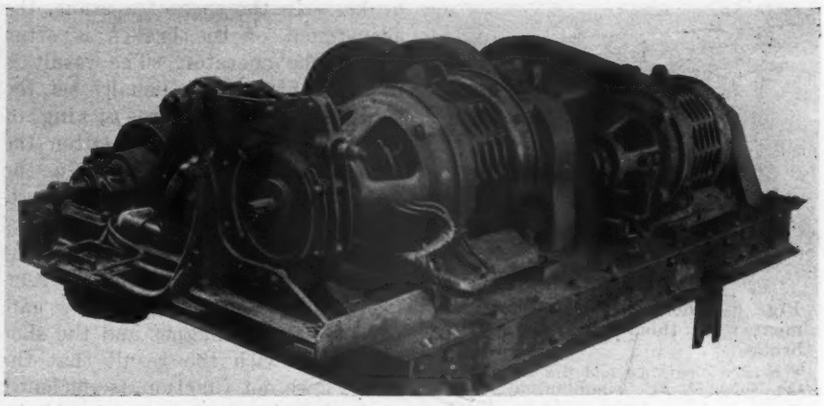
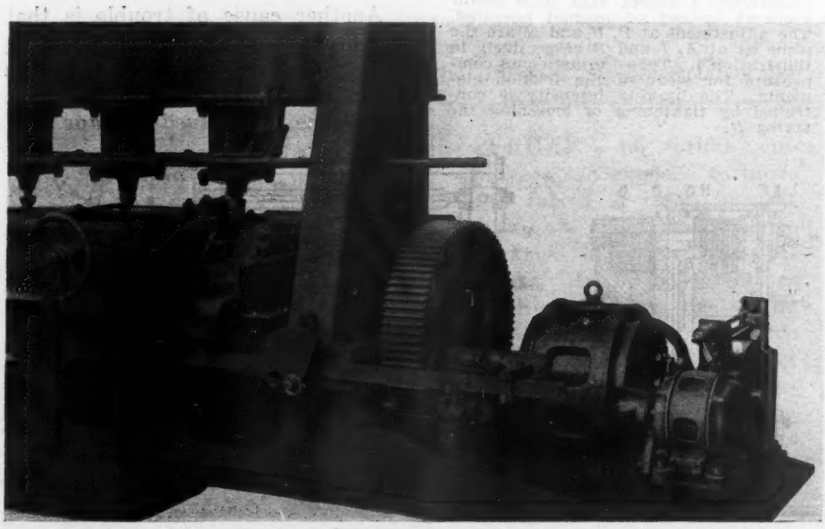


Fig. 4—This is an alternating-current, shoe-brake that is operating on the hoist motion of a crane.
The trolley carriage was not wide enough to mount the brake directly on it; so two angles were bolted to the trolley frame as is shown. The brake was bolted to the two angles.

(1) Motor rating: type; full load speed.
(2) Speed of shaft on which brake is to be mounted.
(3) Line voltage: maximum volts; minimum volts.
(4) If d.c.; type of brake winding (series or shunt).
(5) If a.c.; frequency; number of phases.
(6) Winding duty; intermittent or continuous.
(7) Exact bore and keyway in hub. If taper, send sketch or motor frame data.
(8) Nature of load and duty cycle, if available.

Most brakes are mounted separately on the motor bedplate. A few are attached directly to the motor frame. In Fig. 2 is shown a brake attached directly to the motor frame. Spring-operated brakes can be mounted on the floor, wall or ceiling. Gravity-operated brakes, obviously, must be floor mounted. When installing a shoe brake, care should be taken that the brake wheel is exactly centered between the brake arms when the brake is in the released position; also that the brake shoes are parallel to the face of the brake wheel. Likewise in the case of a separately-mounted disc brake, care must be taken that the stationary plates are parallel to the rotating plates. In the case of a band brake the band must be circular with no kinks so that all of its working surface is effectively applied to the face of the brake wheel. If the brake is not properly lined up, the brake linings may bear in only one or two spots, causing very high pressure at these points, which would result in inability of the brake to hold the load and cause slippage.

Fig. 5—This plate planer is equipped with a motor-operated, alternating-current shoe brake.
On this planer the tool rest travels, instead of the planer bed. The tool rest is shown at the left near the hand wheel. Below the hand wheel is the operator's platform which also travels with the tool rest. At each end of the travel of the tool, the brake is required to absorb the inertia of the tool carriage. The brake is the same type as the one shown in Fig. 3.



The electrical connections of a brake are very simple. The series-wound brake is usually connected to the line side of the series field of the motor. It may be placed elsewhere in the circuit, but this is the more common connection. Some shunt brakes are connected across the line, while others have a series resistor with which they are shunted across the line. If the shunt brake is provided with a discharge resistance, it, of course, should be paralleled with the shunt coil.

All brakes are provided with a means of varying the braking intensity. This is accomplished by varying the weight or the length of the lever arm on which it hangs, or if it is a spring-set brake, by changing the compression of the spring. In addition all brakes are provided with an adjustment for the shoe, disc or band clearance. A change in this adjustment also changes the air gap of the magnet or the stroke length of the core of the solenoid. This ad-

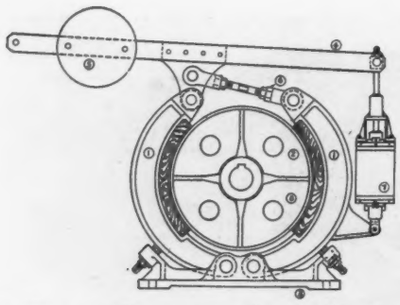


Fig. 6—There are three adjustments on this solenoid-operated brake.

The shoe clearance and the air gap in the solenoid are simultaneously adjusted at (6). The clearance between the two shoes and the brake wheel is equalized by the adjusting screws at each end of the brake frame (3). The braking intensity is controlled by moving the weight (5) along the lever arm, that is marked (4).

justment should be the minimum that will fully release the brake wheel. Making this adjustment minimum gives a minimum air gap which gives a stronger magnet pull and in turn enables the magnet to release a brake with heavier braking power caused by setting up the compression springs or changing the weights. Details of these adjustments are given in the captions to Figs. 6, 7, and 8.

Assigning Responsibility for the Inspection of Brakes

Brakes should be inspected at regular intervals, varying with the conditions under which the brake is operating. A brake operating at its full-torque rating will require adjustment more often than a brake that is operating at only 50 per cent of its torque rating. This time interval can only be determined by experience. If the brake is depended upon to hold heavy loads under emergency conditions or is relied upon to hold the bridge of a crane during strong winds, the inspection should be quite frequent and very thorough.

The question often arises as to who should be responsible for the inspection and maintenance of the electric brakes. In the case of a crane, the adjustment of the brakes is often left to the operator. The result is that the brakes are usually set too tight and cause severe racking of the gears and shafting. Often the responsibility is split between the mechanical and the electrical departments. The mechanic usually keeps the brake bands in good order but seems unable to understand the relation existing between the air gap, the pull of the magnet and the shoe clearance, with the result that the brake does not function as efficiently as it should.

Besides the division of responsibility provides a convenient opportunity for "passing the buck." The adjustment and maintenance of brakes is really a very simple proposition if the workman realizes exactly what he is trying to do. The motor inspector from the electrical department does understand this and it will be found that the most satisfactory operation will be obtained if the entire responsibility for the brakes is placed upon him.

There are not many sources of trouble for electric brakes. Probably the most common complaint is that the brake fails to hold the load or does not stop the machinery soon enough. This is due to incorrect adjustment of the braking intensity. On spring-operated brakes the spring compression should be increased and on gravity-operated brakes either the weight should be increased or the length of the lever arm through which the weight acts should be increased.

Another cause of trouble is that the brakes do not release. This is usually due to the fact that the brake lining has worn to the point where the *(Continued on page 328)*

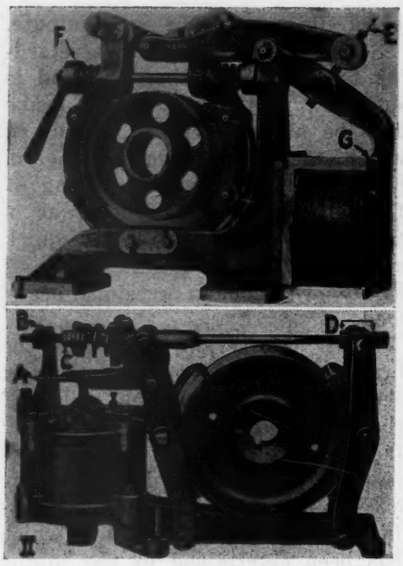


Fig. 7—The brake shown in illustration I has only two adjustments.

The adjusting screw at *E* regulates the air gap at *G;* this in turn determines the shoe clearance when the brake is released, for the movement of the shoe is directly proportional to the movement of the armature through the air gap at *G*. The braking intensity or holding power is adjusted by the handled nut *F*. This compresses or relieves the compression on the spring. In the brake shown in II, there is a pointer at *A*, moving over a scale placed immediately behind it. When the brake is set, the pointer should be in line with the lower of the two marks on the scale. As the lining on the brake shoes wears, *A* will fall below the lower mark. By the adjustment at *D*, the pointer *A* can be brought back to the mark. The clearance between the shoes and the brake wheel is adjusted at *D*. The braking force is determined by the adjustment of the nut *C* against the spring.

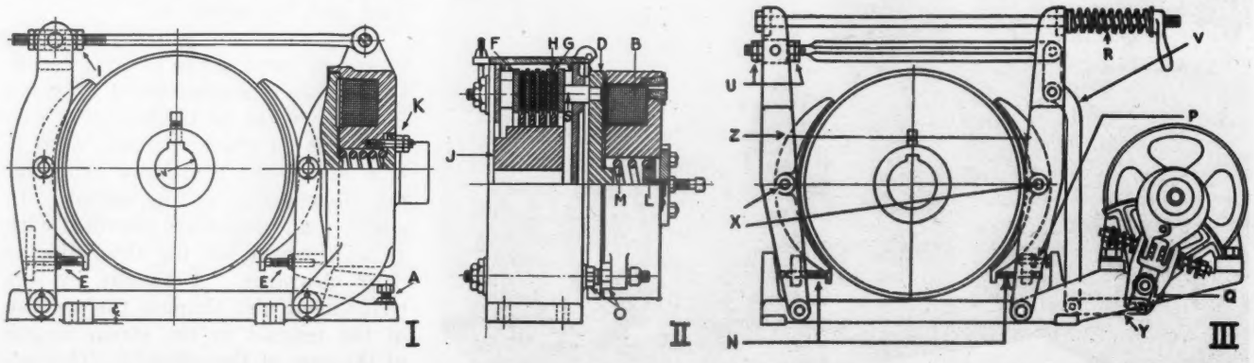
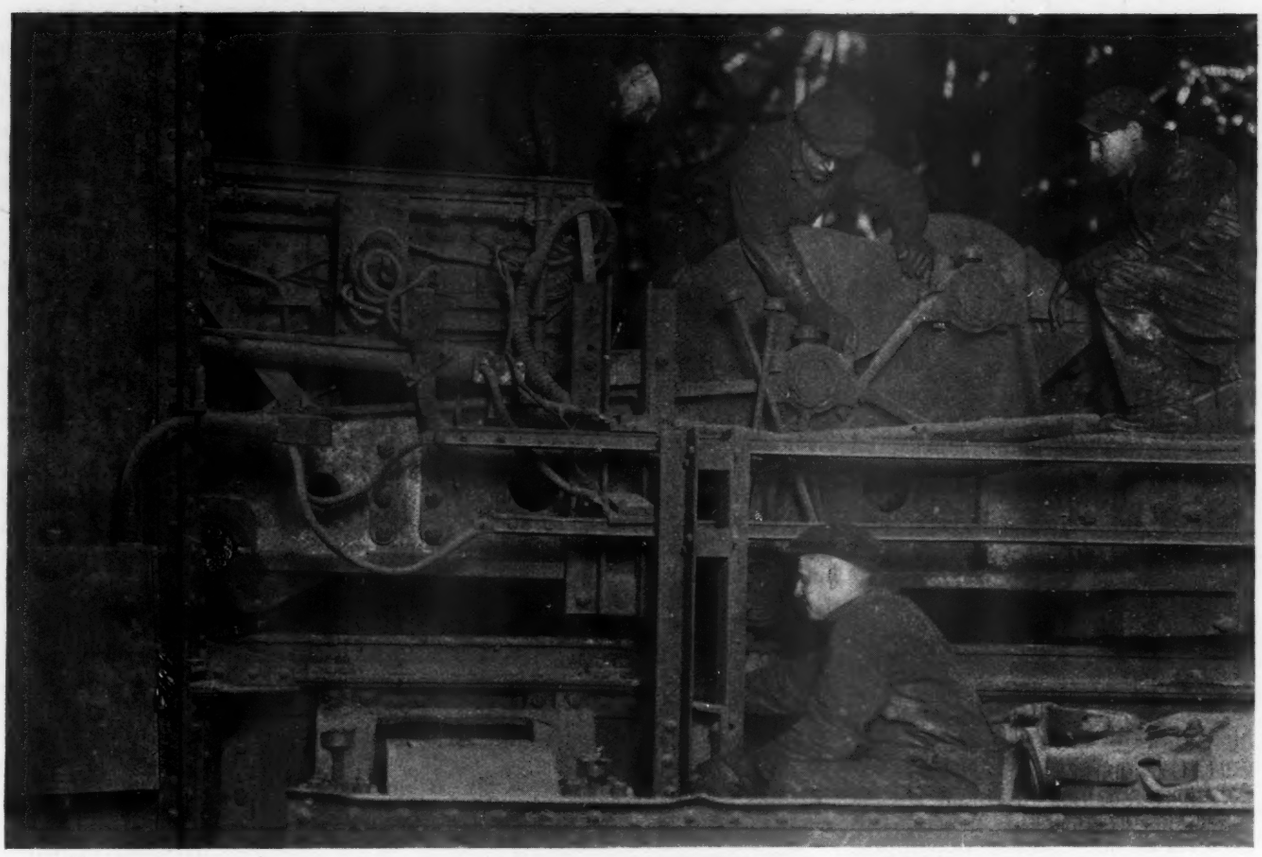


Fig. 8.—Method of adjusting three different types of brakes.

In illustration I is shown a series-wound, direct-current, magnet-operated shoe brake. The shoe clearance is adjustated at *A*, *I* and *E*. With the brakes released, the stop screw *A* is adjusted so that a $\frac{1}{16}$-in. feeler can be inserted between the wheel and the right-hand shoe at the center line. The left-hand shoe is similarly adjusted by the adjustment at *I*. The screws *E* are adjusted so that with the brake released the shoes will have the same clearance at top and bottom. The braking intensity is varied by the adjustment of *K*. In illustration II is shown a direct-current disc brake. Adjustments to compensate for the wearing of the friction elements is accomplished by the adjusting nuts at *O*. Braking intensity is controlled by adjusting the setscrew bearing against the collar *L*. In illustration III is shown a motor-operated, alternating-current brake. This brake is quite similar to the brake in illustration I except that it is motor operated instead of magnet operated. The adjustment at *P*, *U* and *N* are the same as at *A*, *I* and *E* respectively in illustration I. These adjustments compensate for wear of the friction elements. The braking intensity is controlled by tightening or loosening the spring *R*.



Padlocked switchboxes, such as this, protect men and machines. Starting a partially dismantled machine may damage the machine as well as injure the repair man. Each of the four men has his lock on the switch box.

Responsibilities and Activities of the

Maintenance Department In Industrial Safety

Together with a Discussion of the Value of Safety and Some Precautions Which May Be Taken to Protect Maintenance Men at Their Work

By H. W. DONALD

District Manager of Engineering, American Mutual Liability Insurance Company of Boston, Boston, Mass.

PLANT MAINTENANCE differentiates the well-kept, safe, successful, going concern from its ill-kept unsuccessful neighbor. Those plants which do not pay sufficient attention to proper maintenance are more often shut down for repairs, and subjected to repeated interruption of production while machines are "fixed" or "nursed" along to be patched up out of hours, or burnt out by accumulation of debris due to slack housekeeping. It is noteworthy that such plants generally have a pronounced shifting of personnel because they are shunned by good employees. In surveying the progress in industrial activities during the past ten or twenty years, one is impressed with the greater attention given to maintenance along with safety work since Workmen's Compensation has become an expensive factor in industry.

PERHAPS no other employees are exposed to more and varied accident hazards than are the maintenance workers in the industrial plants. Mr. Donald describes in this article some of the precautions maintenance men can take to protect themselves and fellow workers as well as methods by which they can help in reducing the cost of accidents.

The cost of Workmen's Compensation, which is an insurance premium in most plants, is based upon a schedule rating which is affected largely by the physical condition of the individual plant. A swing of 30 to 40 per cent up or down in the insurance cost is not unusual between two plants similar in product, equipment and size. Observation has shown that a large proportion of accidents is still directly attributable to poor maintenance of walks, ways, machinery and plants, just as a large part of depreciation of plants and equipment is due to poor maintenance rather than to faulty design or use.

Maintenance may relate merely to keeping the wheels turning with a roof above them. It may relate to the intricate adjustment and set-up of machines in process of production, or it may relate to the comfort

and safety of the workers. Their requirements, although in the past considered on a flexible basis, are found every day to demand more rigid standards if success is to be achieved in present-day competition. This arises not so much from the demands of the employees as from the scientifically demonstrated rules of efficiency. Uncongenial working conditions increase labor turnover. A serious accident may close down, or at the very least slow up, a department, or the entire works, according to the prevailing temperament of the force, and every injury suffered invariably spins a thread of antagonism which is undesirable under any labor conditions.

Before going further into a discussion of the part that maintenance takes in accident prevention, it may be well to state that safety work consists of two elements: (*a*) Education of the employe into an appreciation of the importance of being a careful worker and what it means to him, and (*b*) safeguards and other protective measures which make it difficult for a man to get hurt. Although the maintenance workers can perform an important service in promoting the education of the other workmen, largely by the example of their own carefulness and attitude toward all safety activities, they are more closely connected with the second of these divisions of safety work.

While it is the duty of the management to see that adequate lighting, ventilation, proper working temperature and humidity, and sanitation are provided and that fencing of moving machine and power transmission elements, protection of floor and wall openings, and repair of floor and wall surfaces and structures where patent defects exist, are made as necessary, the maintenance organization, however, is usually called upon to install and look after the operation of safeguards as well as the equipment and to make any other changes necessary. Regular inspection with adequate records to prevent failures in plants and equipment from latent defects are an important part of the control of these activities.

When considering maintenance and its application to health and safety, there are two sides to consider: The safety of the repairman himself, and the safety of the other employees. Perhaps no group of workers is more frequently brought within the line of personal danger than the maintenance force.

To a certain extent, maintenance men may be put into one class for the purposes of present consideration, as the hazards are similar to woodworkers, metal workers, pipe and steam fitters, electricians, builders, machine fixers and set-up men in innumerable industries. A certain knack or genius is necessary to the job, an ability to make things go, and the dangers are very much alike.

Formerly, under the assumption of risk of the common law, the repairman was not protected if injured while in the process of repairing a machine, and he frequently had difficulty in obtaining damages for injuries so sustained. This is not so today, and he is compensated for injuries occurring during the course of his employment and growing out of it, just as much as anyone else.

His injuries can largely be attributed to the familiar non-mechanical causes of: Handling materials, hand tools, striking against objects, burns, electric shock, flying objects striking the eyes, and the general mechanical hand and tool injuries due to handling machines while in motion, or inflicted by machines put in motion by others while under repair.

The safety activities of these maintenance workers will be discussed here in connection with some of the more important jobs and the incidental danger, together with the safety measures and other precautions which may be taken in the protection of themselves, the operators, other workers and the equipment. For example, the electrical workers have many hazards incidental to their work which they can guard against by carefulness and by the many improvements in switches and other protective equipment. A big hazard results from the possibility of unsafe actions of others. This must be guarded against as well.

Perhaps the first rule of all electrical workers, or any other worker who may be called upon to fix or adjust a machine, is to disconnect by switch or otherwise the machine or power circuit worked on. Even then, the danger of another throwing in the circuit or starting the machine is so great that the frequently used "Danger" or "Man Working on Machine" sign can hardly be relied upon. In spite of rules against the unauthorized removal of such signs, many accidents are the result of such acts. The only safe and secure way is for each worker to close by his own padlock, the switchbox or other disconnecting devices so that no one else can tamper with them. Such a case is shown in the illustration at the head of this article where four men repairing a machine had each placed his lock on the switch box after disconnecting the power. Other illustrations show different applications of lock equipment. It should be unnecessary to caution against using cheap padlocks which are easily unlocked by many different keys.

The objection is sometimes raised that the men may neglect to remove their padlocks and so tie up a ma-

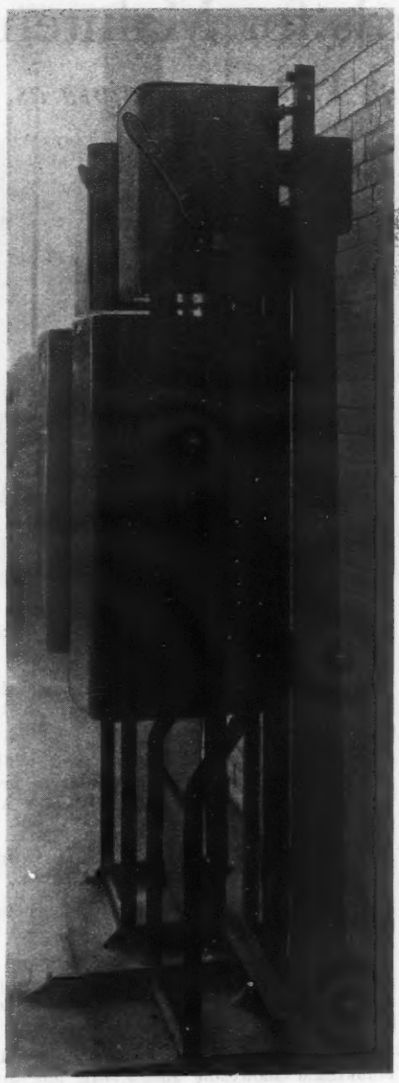
The fourth man on the job inserts his red safety lock before starting.

Even though three locks are already on this switch box, this does not make it safe for the fourth worker as the other three men may complete their part of the work and remove their locks before he is through. This shows in detail the switch box on the charging car, also shown at the heading of this article. These two, and several other pictures in this group were taken at the South Works of the Illinois Steel Co. and at other plants of the United States Steel Corporation.

chine longer than necessary. This, however, is a matter of supervision and probably would never occur more than once. At any rate, the result would never be as serious as it might be if a "Danger" sign were removed or accidentally fell off.

Ladders are responsible for many of the injuries to maintenance workers. These are due to slipping, to reaching too far instead of moving the ladder, and to the use of poorly constructed, broken, or patched up collections of sticks loosely nailed together which hardly deserve being called a ladder. It is surprising how many of this last type are still in use. Slipping may be prevented by non-slip footings on ladders or, when possible, by hooks at the top of the ladder which may be caught over some overhead object, such as a lineshaft. Prongs are commonly used on the foot of ladders as non-slip devices but cannot be relied upon for concrete or hard flooring. Also, men have injured their feet when forcing the point down to "set" it in the flooring.

Instead of using portable hand ladders to get at motors and other equipment mounted overhead, it is usually best to build permanent ladders, as they absolutely eliminate the ladder-slipping hazards and are always on hand for emergency inspections or other attention. Where considerable overhead work is to be done, it pays to build a portable platform. Some shops have such platforms of a convenient height for lineshaft or other overhead work placed permanently in each department. Any inspection routine should include a careful examination of all ladders and platforms. To be sure that all ladders are inspected each time, it is well to identify each with a tag or painted number and see that all are accounted for. It would be well, too, to have some provision for condemning those which are not and cannot be made safe. Instead of painting, it is also better to oil or shellac ladders and leave them in the natural wood so that any crack or split will be visible at once.



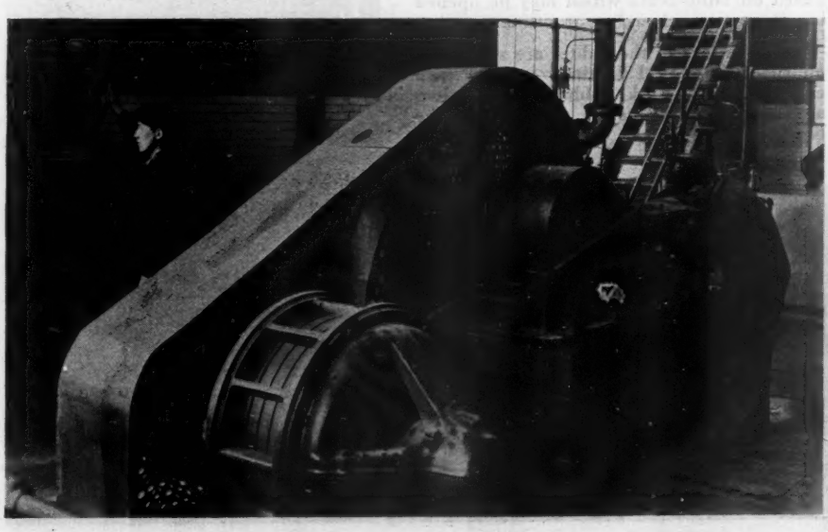
The compensator for the motor which drives the air compressor in the accompanying illustration was locked in this manner.

Staples are attached to the moving parts of the compensator handle and also to the box. When the power is thrown off and the lock inserted no one can move the handle without the key. As the workman alone carries this, he is safe at his work.

While shafting offers the greatest danger to oilers, other workers are injured by contact with it. For example, during the past twelve months, two painters have been whirled to death on shafting. The accident report read, "While stooping to put brush in pail, loose jumper wound around shaft." As the shafting was located about 3 ft. below a 20-ft. ceiling, no one anticipated the possibility of that accident. Perhaps those human sacrifices will save others, for now the painters are required to hang a board between them and the nearby shafting while they are working on ceilings and upper walls. This safeguard is simple since the need of it has been pointed out and consists of one board, two strings and two nails. The nails stay in place and are ready every time the maintenance program brings the painters back. The board is moved along as the position of the scaffolding is changed.

This kind of accident also points out another hazard to maintenance workers. Loose clothing, rings and loose neckties are likely at any time to get caught on moving machinery and draw the worker into it. The danger is somewhat greater to maintenance men in that their work requires close proximity to moving parts of many machines with which they are often not familiar. No other employe is ever called upon to put his arms and hands so near pulleys, gears, belts and shafts as is the maintenance man. Very frequently his familiarity with this work breeds a contempt and disregard for the danger. The prevention of the wearing of loose clothing is a matter of supervision and education of the worker to the hazards involved.

That division of maintenance work



The repairman works on this air compressor without fear, and in safety.

Before he started on this job, this repairman locked the compensator. Therefore, he does not have to keep one eye on it while doing his work, to prevent anyone coming along and starting up. This illustration shows one of the other workers trying it, but unsuccessfully. The method of locking the compensator is shown in another illustration on this page.

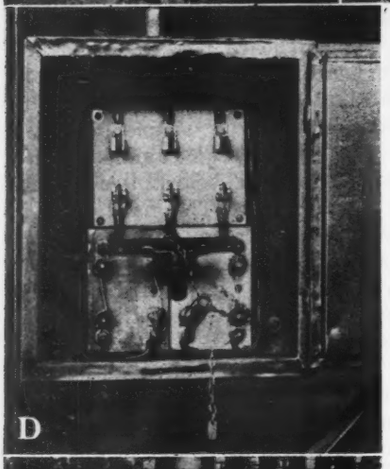
Some Safeguards for Maintenance Workers

Eleven Devices Which Protect Operators as Well as Repairmen

A

B

C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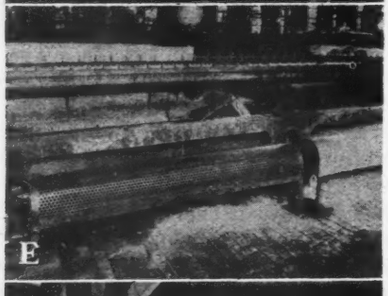
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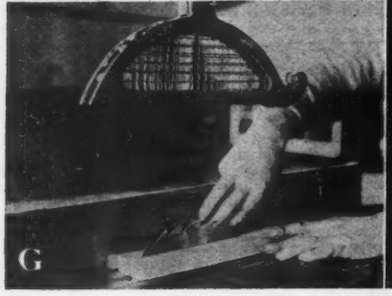
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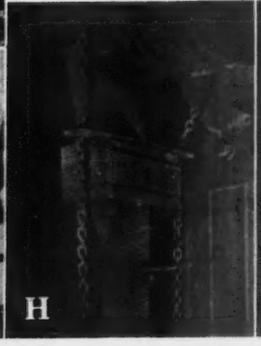
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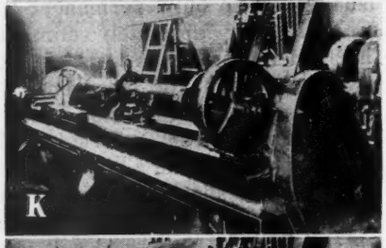
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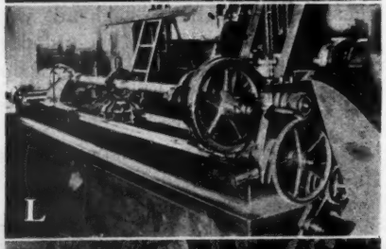

L

M

A—With the steam valve locked, workmen feel more safe in entering boilers.

B—In addition to other safeguards, the passerby is warned of men overhead by danger signs.

C—The blowoff valves are removed while men are working within the boiler to prevent steam from backing up in case another boiler is blown off.

D—One method of locking a knife switch open while making repairs.

E—Guards placed on a lineshaft and coupling located near the floor.

F—Loose clothing caught on this shaft and a man was killed. Bearings which require less frequent oiling decrease the insurance premium rate.

G—Although this man has lost one finger, he is taking a chance on "just a little job" and not setting the guard first.

H and I—Another type of locking device for valves which prevent their being accidentally turned on.

J—This sheet metal guard and danger sign is locked over the handle of the valve to prevent it being turned on too soon.

K and L—These show an effective sheet metal guard on lathe gears which may be opened for inspection, changing or oiling.

M—Here the legs of the ladder are supported on special non-skid footings covered with cocoa matting. Cork, rubber and abrasives are also used frequently. Note also the bracing of the rungs.

connected with the erection and dismantling of machinery and equipment has in addition to the ladder hazard, a hazard of falling material. All chains, blocks, falls and ropes used should be inspected frequently and discarded when they show any signs of excessive wear. Here is another place where the education of the maintenance worker toward exercising extra care and in a knowledge of the loads and stresses involved in lifting heavy weights, is important. Not only are the men in danger, but in addition there is always a possibility of damage to the machinery handled.

Leaving bolts, tools and loose pieces overhead to fall down later due to the vibration of the building can best be prevented by supervision and education of the men. The common practice of carrying an armful of tools up a ladder or tossing them up should be discouraged and the better method of pulling them up with a rope substituted. When men are working overhead, the space beneath should be fenced off or at least protected by signs reading, "Men Working Overhead," or some similar sign to prevent injury to the passing fellow employe.

Unless the maintenance worker appreciates the value of safeguards on machines, it is often difficult to get the men to use them on the saws and other machine tools in their own small shop. The same is true of goggles employed when using grinding wheels or chipping metal. Frequently, this work occupies such a small amount of time and is so special as to require the resetting of the guard that the men do not think it necessary. Besides, they often feel that they are a little more sure than are the other workers. Mushroom tools offer another hazard which can be prevented by adequate inspection.

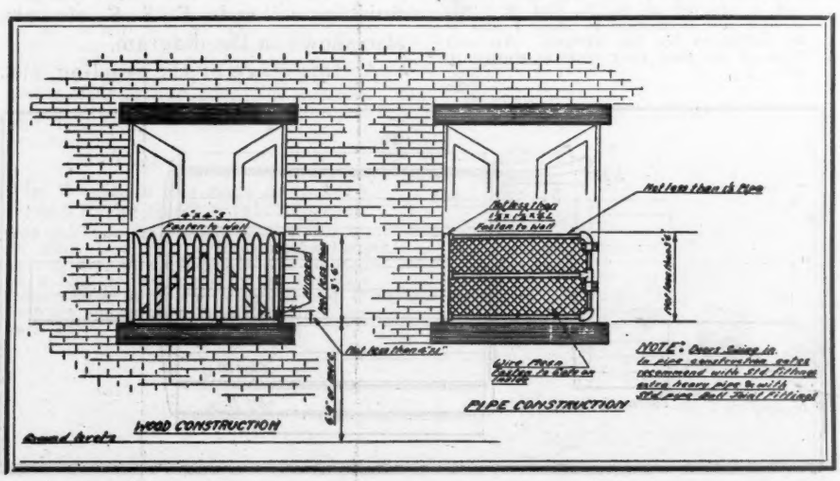
Another arrangement whereby the power circuit can be locked open.
Here a check is attached to the padlock, showing the department and number of the man who has locked the switch open. In this way, it is easy to check up and find why and by whom the disconnect was made.

In his work a maintenance man comes in contact with every hazard incidental to the operation of any department in the plant. For example, with the increase in the use of ammonia, chlorine, hydrogen sulphide and other gases, entirely new hazards are presented to these workers. All workers who may at any time be called upon to do any repair work where they may be exposed to escaping gases should have experience in the use of a gas helmet and a life belt.

Perhaps due to his versatility in being required to repair almost everything, the maintenance worker and the management thinks he knows how to take care of himself and to some extent have overlooked his safety. Rather, however, greater care should be exercised in training him and preparing him to take the precautions necessary for his safety, as he is constantly exposed to new, unexpected and unusual conditions to a far greater extent than are the workers in any other occupation.

An article in a later issue will take up standardized safeguards, inspection methods and organization of safety work with special reference to the part taken in this by the maintenance organization.

These standard types of guards for wall openings have been approved by the insurance companies.
In the construction of safeguards in industrial plants great emphasis is placed on the use of standard forms of guards, approved by the insurance companies. This sketch shows a type of guard approved by the American Mutual Liability Insurance Company of Boston. This is a standard guard for wall openings and may be of either wood or pipe construction.



Works of Shredded Wheat Company

(Continued from page 311)

on an endless chain. Each biscuit is built up of thirty-six layers of separate shreds. A special cutting machine forms this long band of shredded filament into oblong cakes and deposits them on a pan holding fifty-two biscuits. Each pan of biscuits passes through two separate ovens which bake and crisp them. Next, the biscuits are taken to the packing rooms where they are placed in cartons which are carried on a conveyor to a special sealing machine which also dries the vegetable glue used in sealing the cartons.

Two interesting problems of this industry result from the care required in handling because of the fragile nature of the product and also from the increase in bulk of the packed biscuits over the original bulk of the wheat. While this packed and finished product is not heavy, it nevertheless requires large storage area and care in handling.

Details and Diagrams For Making a

Special Chorded Split-Pitch Loop Winding

For Use on Small Motors Together With Complete Information on How to Wind in the Coils And Make the Connections to the Commutator With the Reasons Why and the Advantages Obtained by the Use of Such a Winding

A SPLIT-PITCH winding is one in which each two coils are wound in three slots, the two coils each having a different pitch. In the winding on the motor described in this article, the first coil has a pitch of 1 and 11; the second coil has a pitch of 1 and 10; the third coil has a pitch of 1 and 11; the fourth coil a pitch of 1 and 10, and so on. In this article Mr. Roe tells why and where such a winding is used and the precautions to take when making it.

By A. C. ROE

Repair Superintendent, Detroit Service Dept., Westinghouse Electric & Manufacturing Co.

MANY small, two-pole motors having an armature with a large number of slots and small end-room are wound with a special chorded, split-pitch winding. This winding can be used with any number of slots where there are two or four times as many bars as slots.

This type of winding was used on a 5-hp., 1,110-r.p.m., two-pole motor that recently passed through our shop. The diameter of the armature was 10 in.; it had twenty-four slots and forty-eight commutator bars.

If full pitch, 1-and-13, had been used, the winding would have piled up on the ends of the armature and taken up too much space. This would have been caused by the end turns having to cross the maximum number of coils and also bend around the shaft, since slots *1* and *13* are on diametrically opposite sides of the shaft.

To eliminate some of the coil crossings and to prevent the coil ends from bending around the shaft, the coil pitch was reduced to 80 per cent of full pitch. Full pitch equals 12 on this armature; hence 80 per cent of full pitch would equal 0.80×12, which equals 9.6. This is equivalent to using slots 1 and 10.6. Since 0.6 of a slot cannot be obtained, it was decided to use a split-pitch winding; that is, to wind one coil with a pitch of 10, as 1-and-11, and to wind the next coil with a pitch of 9, as 1-and 10. This gave an average pitch of 9.5, which approximates the desired pitch of 9.6.

This particular winding had odd turns; that is, one coil had seven turns and the second had eight turns. The long pitch, 1-and-11, coil had eight turns, while the short pitch, 1-and-10, coil had seven turns.

Armature Is Wound With One Wire in Hand

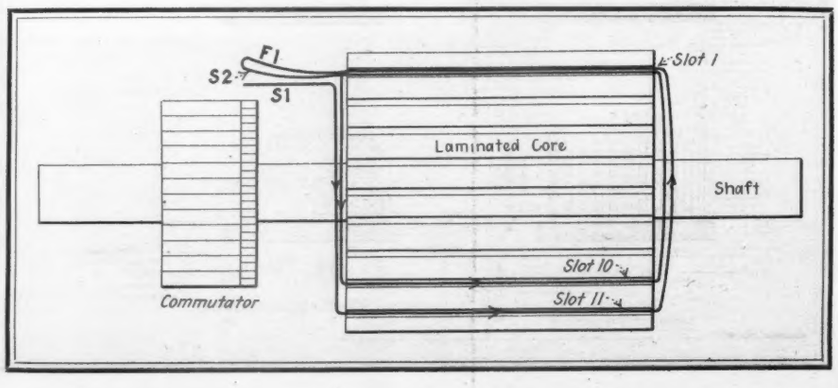
This type of winding must be wound with one wire in hand, regardless of the number of times the commutator bars exceed the slots.

In winding the armature, it should be placed with the commutator on the left-hand side of the winder, as shown in Fig. 1. In this diagram the start of the winding is shown at S_1. The winding can be started from any slot and the slot from which it is started is called slot *1*. The S_1 lead is left long enough to reach to the proper commutator bar, and a white sleeve is put around the lead. The wire is bent down from the front or commutator end of slot *1* and carried across to slot *11*, through slot *11* up the back of the armature to slot *1*, and through slot *1* as shown by the arrows in Fig. 1. Eight turns are wound in slots *1* and *11*. F_1 is the finishing end of the first coil. A loop is then made of the finishing end, F_1, of the first coil and the starting end, S_2, of the second coil. This loop should be long enough to reach to the proper commutator segment and a red sleeve is put on it. The starting end, S_2, of the second coil is carried down the front of the armature to slot *10*, through slot *10*, up the back of the armature to slot *1*, and through slot *1*, as indicated by the arrows in Fig. 1. Seven turns are wound in the second coil. Fig. 2 shows the front end of the armature with the first four coils wound in. In this figure S_1, F_1, etc., refer to the starting and finishing ends of the respective coils, the same as in Fig. 1. The small circles in the slots represent the different coils and the number in the circles indicates the coil number and the order in which the coil is wound. The commutator loops made up of the starting and finishing coil ends, F_1, S_2, S_3, etc., are also shown in the diagram.

At this stage of the winding, slot

Fig. 1—Side view of the beginning of a split-pitch, loop winding.

S_1 is the start and F_1 is the finish of the first coil. This coil consists of eight turns wound in slots *1* and *11*, as indicated by the arrows. At the finish of the first coil a loop is made long enough to reach the proper commutator bar and at the end of this loop the second coil is started at S_2, in slot *10*. The second coil is wound in slots *1* and *10* as indicated by the arrows. An end view of the first four coils is shown in Fig. 2.



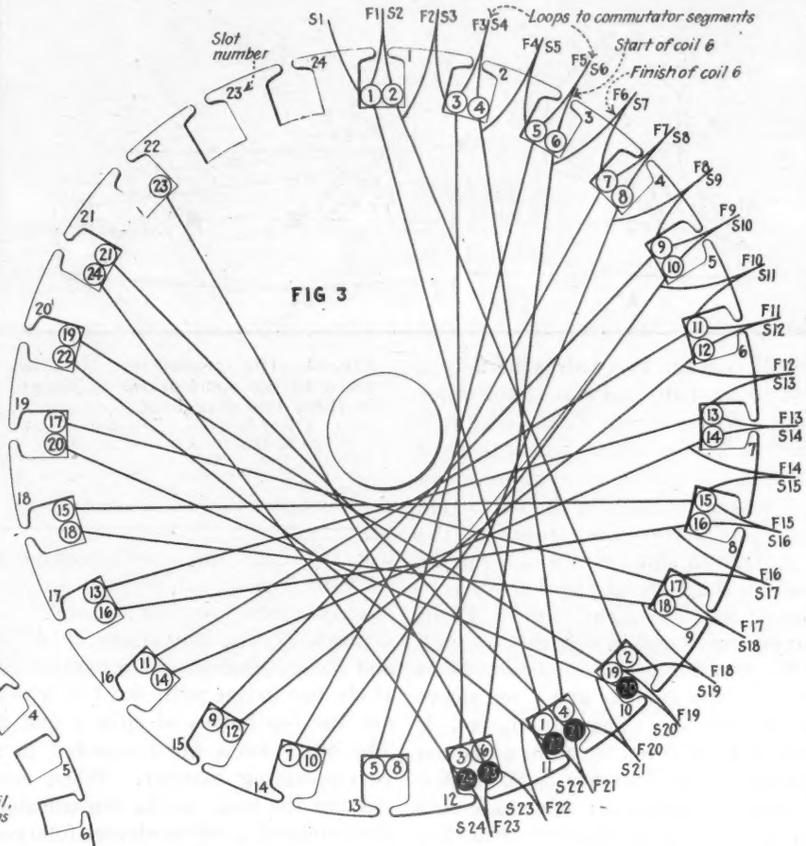


FIG 3

Fig. 2—End view of the winding shown in Fig. 1.

The coil starts at S_1 and consists of eight turns wound in slots *1* and *11*, as shown by the bunch of wires marked *1* in the two slots. A loop is made of the finish of the first coil, F_1, and the start of the second, S_2, which is to be connected to the proper commutator bar. A red sleeve is put over this loop. Beginning with S_2 and ending with F_2, the second coil is wound with seven turns in slots *1* and *10*. At F_1 a loop is made long enough to reach to the proper commutator segment and the third coil is begun at S_3. A white sleeve is put over the loop made by F_2 and S_3. The third coil consists of eight turns wound in slots *2* and *12*.

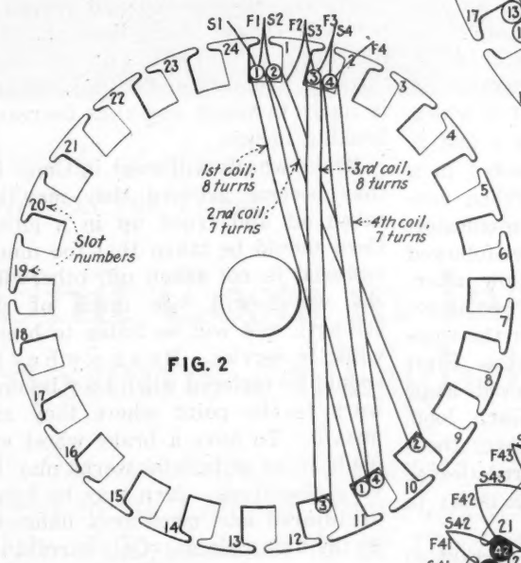


FIG. 2

Fig. 3—This diagram shows the armature with the first half of the coils in place.

Note that the top layer of coils begins in slot *10* with coil *20*. The upper layer coils in each slot are indicated by black circles with white letters. The letters *S* and *F* indicate the starting and finishing leads of each coil. The numbers in the circles indicate the coil number and the order in which the coil is wound on.

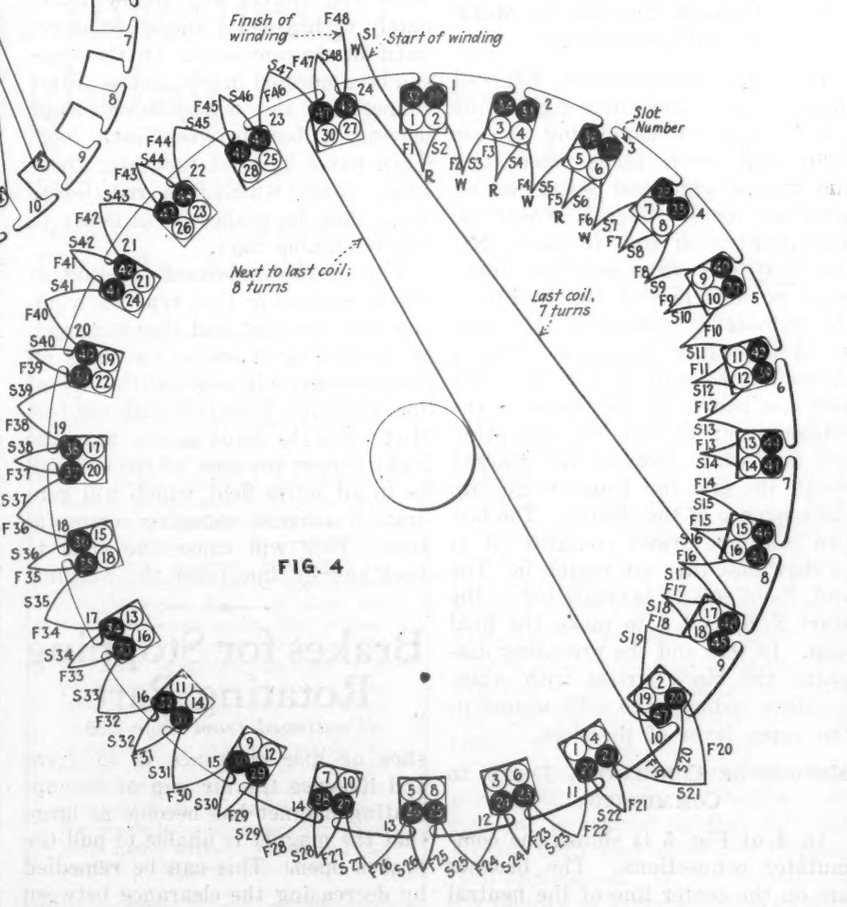


FIG. 4

Fig. 4—All of the coils have been wound in the slots, in this diagram.

The last two coils have been drawn in to show how the winding ends. F_{48} and S_1 are joined together and treated as a loop to be connected to the last commutator bar. The letters *R* and *W* indicate the color of sleeving used for each loop.

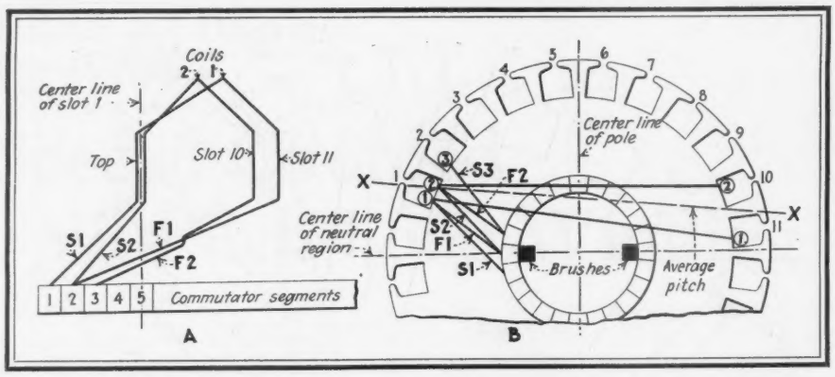


Fig. 5—The connections of the loops to the commutator is shown in these two diagrams.

In *A*, it will be seen that the loop connections to the commutator are given a forward lead. This is to compensate for the chorded pitch. In *B*, coil 2 is shown in position for commutation. The line *XX* indicates the average pitch.

1 will contain two halves of a coil, slot *10* one-half, and slot *11* the other half. With the end F_2 of coil *2* and the start, S_3, of coil *3*, a loop is made on which is put a white sleeve. Coil *3* is wound by running the wire from the loop across the front of the armature to slot *12*, through slot *12* and up the back of the armature to slot *2* and through slot *2*. Eight turns are wound in this coil through slots *2* and *12*. At the finish F_3 of coil *3* a loop is made and a red sleeve is put on it. The fourth coil is wound with seven turns in a manner similar to the previous coils, in slots *2* and *11*. There are now four coils in five slots, as is shown in Fig. 2.

Use of Colored Sleeves to Mark Commutator Loops

The above procedure is followed through until the forty-eight coils are in place, remembering to use eight and seven turns alternately and putting white and red sleeves on alternate loops. Fig. 3 shows the first twenty-four coils in place. Notice that coil *20* starts the upper layer of coils in slot *10*. In Fig. 3 the numbering system is the same as in preceding diagrams. Fig. 4 shows all the coils laid in the slots and also shows all the loops to the commutator; *R* and *W*, indicating red and white sleeves, are marked beside the first few loops to indicate the sequence of the sleeves. The last two coils are drawn complete so as to show how they are wound in. The end, F_{48} of coil *48* is connected to the start S_1 of coil *1* to make the final loop. In this and the preceding diagram, the black circles with white numbers indicate the coils wound in the upper layer of the slots.

Method of Connecting Loops to Commutator

In *A* of Fig. 5 is shown the commutator connections. The brushes are on the center line of the neutral region as shown in diagram *B* of Fig. 5. Hence the leads are given a forward lead to compensate for the chorded pitch. As will be seen from diagram *A*, the loop made up of S_2 and F_1, is connected three bars ahead of the bar in line with slot *1* in which are the top halves of coils *1* and *2*. The other loops are connected in a corresponding manner. When connecting the loops to the commutator, first connect a white sleeve, followed by a red sleeve, and follow alternately with a white and a red sleeve until all are connected. Or the loops can be connected in two layers. First connect all the white-sleeved loops leaving a bar between each loop. Then put a band of tape over these loops, after which the red-sleeved loops may be connected in order to the remaining bars.

The most important precaution when connecting this type of winding is to get the lead throw correct, as connecting it one or two bars off will considerably shorten the life of the winding. This is due to the fact that when the leads do not have the right throw, one part of the coil will be in an active field, which will generate a current opposing commutation. This will cause the coils to heat and in time roast the winding.

Brakes for Stopping Rotating Parts

(Continued from page 320)

shoe or disc clearance is so great and likewise the air gap of the operating magnet has become so large that the magnet is unable to pull the brakes open. This can be remedied by decreasing the clearance between the shoes and the wheel; this in turn decreases the air gap of the magnet and permits it to exert a greater pull to release the brake. On solenoid-operated brakes, excessive shoe clearance causes the core of the solenoid to fall too far through the coil, thus decreasing its pull. The remedy is to decrease the excessive clearance between the shoes and the brake wheel, the same as in the case of the magnet-operated brake.

Occasionally the operating coil grounds or shorts, either due to vibration or to imposing too heavy duty on the coil. It is obvious that a half-hour rated coil for crane service cannot be expected to stand up under 60-min. mill service. The remedy is obvious. Coils may be easily removed and repaired or replaced with new ones.

The linings on the shoes, bands, or discs must be watched and replaced before they are worn through. If the lining is permitted to wear through, grooving of the brake wheel is likely to result and thus decrease braking torque.

Brake wheels will wear in time. If they become grooved they may be taken off and trued up in a lathe. Care should be taken that too much material is not taken off, otherwise the wheel will lose much of its strength and will be liable to break while in service. Brake wheels should be replaced when they become worn to the point where they are unsafe. To have a brake wheel explode in an industrial works may be very disastrous. Men may be killed or injured and machinery damaged by the flying pieces. Only careful inspection and maintenance can prevent disastrous occurrences of this kind.

Editor's Note: Special acknowledgment is made to the following companies for assistance in furnishing information, data and illustrations for this article: Allis-Chalmers Mfg. Co., Milwaukee, Wis.; E. C. Atkins & Co., Indianapolis, Ind.; Commercial Chemical Co., Boston, Mass.; Cutler-Hammer Mfg. Co., Milwaukee, Wis.; Electric Controller & Mfg. Co., Cleveland, Ohio; General Electric Co., Schenectady, N. Y.; Kelso Mfg. Co., Trenton, N. J.; Sundh Electric Co., Inc., Newark, N. J.; Thermoid Rubber Co., Trenton, N. J.; Tool Steel Gear and Pinion Co., Cincinnati, Ohio; Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa.

In compiling this article information has been obtained from a chapter on electric brakes in a new book, "Principles of Electric Motors and Control," by Gordon Fox, published by the McGraw-Hill Book Co., and also from an excellent paper, "Auxiliary Electrical Equipment for Motor-Operated Cranes," presented before the A. I. E. E. in 1922 by H. W. Eastwood.

This photograph was taken in the Harrisburg (Pa.) Silk Mill. The lighting system uses one Holophane No. 621 intensive type reflector with a 200-watt lamp hung over the center line of the fronts of each two looms. The spilled light from these units is considered adequate for the illumination of the backs of the looms. The intensity in the front of the looms is 30 foot-candles and at the back of the looms 12 foot-candles. The cost of this installation was one-half cent per foot-candle per square foot.

Details of a Method for Using

Unit Costs in Installing Systems of Lighting

To Obtain a Quick Estimate of Costs When the Area to Be Lighted, Foot-Candles of Intensity and Type of Equipment to Be Used Are Known

By DAVIS H. TUCK
Electrical Engineer, Holophane Glass Co., New York, N. Y.

THIS ARTICLE was presented by Mr. Tuck before the last annual convention of the Illuminating Engineering Society as a guide in the preparation of estimates on the cost of lighting required for different industrial operations. It shows how to secure lighting equipment and layouts that not only provide the necessary lighting intensity but have low unit cost of installation. The unit-cost basis in cents per foot-candle per square foot of floor space in estimating both installation and operating expenses is of practical value to both the man who is to pay for the installation and the man who works up the estimate as an installation job. In many cases a study of unit-cost figures of installation and of operation will make it possible to secure the lowest possible expenditure for both items without sacrificing the quality of lighting provided.

IN THE PAST, industrial lighting cost figures have been based on one 100-watt outlet or on a complete installation in one department. Such figures are of little practical value, inasmuch as they have no common basis. Also, such cost figures as have been used in the past, have no direct bearing on the amount of illumination that is received for the money paid out. Thus, when it is stated that the total annual cost of eight 400-watt lighting units is $340.00, this $340.00 has no practical significance, until it is reduced to some unit cost, and unless additional data are given, such as the type of reflector equipment, the floor area to be illuminated, and such other data as will determine the utilization coefficient, this common basis cannot be arrived at. When it is remembered that it is foot-candles at the work, and not watts at the socket, that are bought and paid for, it is seen that the unit cost of lighting should be based on foot-candles at the work.

In the case of the lighting installation already referred to, where eight 400-watt lighting units cost $340.00 per year, it was found that a uniform illumination of ten foot-candles was obtained over an area of 3,200 square feet. It would follow that the logical unit cost would be $340.00 ÷ (10 x 3200) = one cent per foot-candle for each square foot. This is equivalent to saying that one effective lumen per square foot costs one cent for this particular installation.

The cost in cents per foot-candle per square foot is the logical unit cost for industrial lighting and has already been used effectively in practical application. In one instance, a silk factory in Virginia wired an elec-

trical contractor in New York City for a price on re-lighting their *Weave Department*. The contractor answered by wire that it would cost one half of a cent per foot-candle per square foot of floor area and received a wire to proceed with the work.

The unit cost of lighting expressed in cents per foot-candle per square foot can be divided into two parts: (1) Unit installation cost and (2) unit operating cost.

Unit Installation Cost

The unit cost of installation in cents per foot-candle per square foot is of practical value and interest both to the electrical contractor and the owner. The contractor who has kept unit cost figures in cents per foot-candle per square foot soon arrives at unit-cost figures which will apply to various types of industrial installations and can devise methods of lighting which will lower these unit-cost figures. Thus, if a contractor has installed several lighting installations in *Weaving Departments* of silk mills and finds that the unit installation cost in cents per foot-candle per square foot is one cent when one type of installation is made and that by using careful design this unit installation cost may be cut to one-half of a cent, he is evidently at an advantage as regards competition.

The unit cost of installation is arrived at in the following way:

Cost of reflector equipment (consumers discount) ....$.....
Cost of lamps on (consumers discount basis) ....
Cost of wiring (to consumer) .....
Incidentals (certificate, extras, etc.) ....

Total cost of complete job (Contractor's bill) = C..$.....

Calculated illumination intensity checked after installation with a portable illuminometer = E

Total number of square feet of floor area served by the lighting equipment = A

Then the unit cost in cents per foot-candle per sq. ft. = $(C \times 100) \div (E \times A)$.

To the owner, the unit installation cost of lighting in cents per foot-candle per square foot is a logical and convenient figure. If the owner has made a definite appropriation for the installation of lighting equipment, all he has to do is to divide this appropriation by the number of square feet to be illuminated and by the unit cost of installation and the result will be the illumination received on the work in foot-candles.

Table I—Unit Cost of Installation in Cents Per Foot-Candle Per Square Foot for Various Types of Industrial Lighting Installations

Industry	Type of Reflector	Area per Sq. Ft.	Average Foot-Candles	Unit Cost Cents per Foot Candle per Square Foot
1. Wool Yarn Mule Spinning	Hol. No. 621	12,000	30	0.48
2. Metal Stamping	RLM	5,424	3.5	2.95
3. Elec. Mfg. Assembly small parts	RLM	6,860	11	1.78
4. Wool Weaving	Porcelain Enam. Shallow Dome	4,888	11.9	2.45
5. Knit Goods. Knitting Mach.	RLM	3,200	5.6	1.23
6. Soap Mfg. General	RLM	7,974	2.5	2.68
7. Struc. Steel. General	Porc. Deep Bowl	208,380	2	0.66
8. Auto Mfg. Paint Shops	Deep Bowl Steel Enam.	48,000	3.5	1.01
9. R. R. Repair Shops	Deep Bowl Steel Enam.	3,264	1.7	0.52
10. Aluminum Spinning	RLM	29,680	3.6	1.25
11. Office Coal Company	Filterlite Enclosing Glass	5,500	3.0	5.14
12. Silk Weaving	Hol. No. 621	12,000	30	0.50

On the other hand, if the owner knows the unit installation cost of the lighting to be done and the intensity of illumination required, the installation cost can be arrived at by the simple relation shown above.

The unit cost of installation has been kept for several types of lighting installations, several of which are shown in Table I.

The unit installation cost for direct lighting of the RLM industrial type is indicated in Table I as roughly two cents, and that of semi-indirect lighting characteristic of a high-class, totally-enclosing globe type indirect 69 per cent, direct 31 per cent (Item 11) is 5 cents.

Item 9 has a low unit cost, 0.52 of a cent per foot-candle per square foot, because 750-watt lamps were used, thereby lowering the installation cost and the cost of the reflectors.

The low unit installation cost of Items 1 and 12 are due to the method of installation. In both these cases the localized general type of installation was employed and due to the intensive type of light distribution, a high illumination intensity on the looms was received at the expense of the aisle illumination. It is to be noted that in such cases where

Fig. 1—Localized general lighting in the Arohnson Silk Weaving Mill, at Coatesville, Pa.

This installation uses one Holophane No. 621 intensive type reflector with a 200-watt lamp placed over the center line of the fronts of each two looms. One Holophane No. 622 intensive reflector with a 200-watt lamp is placed over the center line of the backs of each four looms. There are 150 watts for each loom with this arrangement. The intensity at the front of the looms is 25 foot-candles and at the back of the looms 15 foot-candles. The cost of this localized general lighting was seven-tenths cents per foot-candle per square foot.

the illumination is not uniform over the entire floor area unit cost expressed in cents per foot-candle per square foot is in a way a misnomer, inasmuch as the foot-candles times the square feet of floor area do not give the total useful lumens. When interpreting unit costs of lighting for non-uniform systems, the nature of the work must be taken into account.

Thus, in the case of Wool Yarn Mule Spinning, the working plane is limited to the strip of shaded area (see Figure 2). If, therefore, the light from the lamps can be concentrated on this strip of working plane and gradually shaded off in the aisles, the apparent coefficient of utilization can be increased and the unit cost installation lowered.

We have become accustomed to speak of useful lumens, as those lumens which were delivered to an imaginary horizontal plane about 30 inches above the floor and the efficiency of utilization is taken as the ratio of these useful lumens to the total generated lumens. It is entirely possible, however, to have some useful lumens that are more useful than other useful lumens. For instance, in Fig. 2, the lumens in excess of 3 per square foot in the aisles and non-shaded portion are not as useful as those in excess of 3 in the shaded portion.

How this idea of some lumens being more useful than others works out in practice toward lowering the unit cost of installation, is seen by the following example.

It is desired to illuminate the mules previously referred to, (an actual installation) to an intensity of 30 foot-candles. The floor area occupied by the spinning department is 12,000 square feet; when the uniform system of illumination was used, the unit cost based on RLM reflectors and 200-watt lamps was 0.88 of a cent per foot-candle per square foot. When the localized general system of illumination is employed where it is recognized that the lumens on the work are more useful than lumens in the aisles, the unit cost of installation was only 0.48 of a cent per foot-candle per square foot.

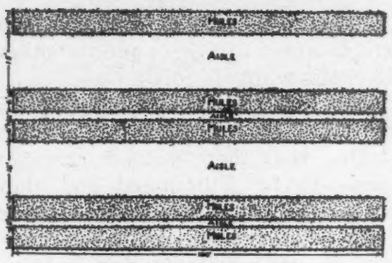


Fig. 2—A floor plan of a part of a mule spinning room in a wool yarn factory.

Unit Cost of Operation

The unit cost of operation in cents per foot-candle per square foot is of more interest to the owner than to the electrical contractor. In the same way that the owner really buys the installation of a definite number of foot-candles of illumination, he also pays for the operation of a system that will maintain a definite number of foot-candles on the working plane.

The unit cost of operation is arrived at as follows:

Six per cent on total cost of installation (contractor's bill) .$.....
Percentage depreciation on equipment (contractor's bill less lamps) .....
Lamp renewals based on 1,000 burning hours as the life of the lamp .....
Cost of current.....
Cost of cleaning.....
Incidentals .....

Total operating cost, C ...$.....

Actual average intensity in foot-candles as read before and after cleaning intervals $= E$.

Total number of square feet of floor area served by the lighting equipment $= A$.

Then the unit cost of operation in cents per foot-candle per sq. ft. $= (C \times 100) \div (E \times A)$.

The unit cost of operation has been kept for the same installations as shown in Table I. Table II shows the unit cost of operation of these several typical installations.

Table II indicates that the unit cost of operation for direct illumination of the RLM type is roughly 1.3 cents per foot-candle per square foot and that the unit cost of semi-indirect (indirect 63—direct 31) lighting of a high-class totally enclosing globe is roughly 2.3 cents per foot-candle per square foot. It will be noted that the unit cost for the RLM installation varies from 1.0 to 1.6 and this difference is due to the way in which the installation was planned and the degree of depreciation that had set in at the time of the illumination test.

The low unit cost of operation for items 1 and 12 are due to the method of installation as had already been pointed out under unit cost of maintenance. It is here that the great benefit to be obtained by a properly planned system of localized general illumination is realized, for, whereas the low unit cost of installation for such a system is evident, this cost is not of as great importance as the unit cost of operation, inasmuch as the latter must be met every day, and such a saving is cumulative.

Upon an examination of the formulas for the unit cost of installation, it is evident that in order to lower this unit cost, the foot-candles of illumination must be increased or the cost of the equipment must be decreased or both. Inasmuch as the cost of lamps and labor of wiring and hanging the reflector equipment are stable quantities, the reflector equipment is the only item where a

Table II—Unit Cost of Operation in Cents Per Foot-Candle Per Square Foot for Various Types of Industrial Lighting Installations

Industry	Type of Reflector	Area	Average Foot-Candles	Unit Cost Cents per Foot Candle per Square Foot
1. Wool Yarn Mule Spinning	Hol. No. 621	12,000	30	0.36
2. Metal Stamping	RLM	5,424	3.5	1.60
3. Elec. Mfg. Assembly small parts	RLM	6,860	11	1.20
4. Wool Weaving	Shallow Dome Porcelain Enam.	4,888	11.9	1.60
5. Knit Goods—Knitting Mach.	RLM	3,200	5.6	1.01
6. Soap Mfg. General	RLM	7,974	2.5	1.63
7. Structural Steel. General	Porcelain Enam. Deep Bowl	208,380	2	1.3
8. Auto Paint Shop	Porcelain Enam. Deep Bowl	3,264	3.5	0.98
9. R. R. Repair Shop	Porcelain Enam. Deep Bowl	48,000	1.7	1.47
10. Aluminum Spinning	RLM	29,680	3.6	1.26
11. Office Coal Company	Filterlite Encl. Glass 69-31	5,500	3.0	2.3
12. Silk Weaving	Hol. No. 621	12,000	30	0.45

saving can be made. It is entirely possible, however, to increase this reflector factor of Item *C* and reduce the unit cost of the illumination by using more effective reflector equipment. An example of this method of reducing the unit cost of installation is shown in Items 1 and 12 of Table I. The unit cost can also be reduced by using a few large units in place of many smaller units. This latter reduction in unit cost, however, is ordinarily made by sacrificing the quality of the light. In some instances, however, in such locations as an armory, power plant, foundry, gymnasium and industrial plants where the locations of craneways make it necessary to mount the luminaires relatively high (25 feet or more above the floor), it is possible to reduce the unit cost of installation greatly, without sacrificing quality of illumination, by the installation of large lamps in reflectors of the intensive type. By using reflector equipment having a well pronounced intensive type of distribution hung high it is possible in such cases to reduce factor *C* and increase factor *E* in the formula for unit cost of installation and operation with a corresponding reduction in the unit cost.

In the case of yard lighting, it is practical to decrease the unit cost of installation by the use of refractor equipment in place of ordinary reflectors. When refractors are used, the spacing can be made as great as 12 times the mounting height and illumination obtained of a uniformity equal to ordinary reflectors spaced four times the mounting height. By decreasing the number of posts and outlets, the installation cost for the yard lighting system is cut down.

The unit cost of operation can best be lowered by increasing the efficiency of the system, inasmuch as the cost of the current is the largest item of expense in factor *C* of the formula for unit cost of operation.

Comments by Other Illuminating Engineers

Davis H. Tuck: Since writing this, we have put in some industrial yard lighting systems and have found the unit cost of installation to be roughly 13 cents per 100 square feet of industrial yard. The illumination in foot-candles in such a yard is three-tenths of a foot-candle, the poles are about 30 feet high and are spaced 240 feet on centers, using 500-watt lamps. We have checked the unit cost on two yards, one of which came to 13 cents and the other 15 cents, which is fairly close.

To show you how that applies, I received a letter just a few days ago, stating that there were 5 acres of yards to be illuminated and they asked about how much this would cost. Evidently the man wanted to get an appropriation for lighting those yards and he wanted some idea as to the cost. Using the average of 13 and 15 cents which we had obtained for similar yards, we were able to give him a rough estimate of the cost of his yard lighting within $100 one way or the other. This illustration shows the practical importance of such unit cost figures.

H. W. Desaix: I had both the pleasure and the privilege of collaborating with Mr. Tuck in the compilation of the information contained in his paper. I also know from actual experience that this works out very well in practice, particularly in some classes of industrial plants.

For instance, in the silk industry with which I am most familiar, building costs are actually handled on the basis of cost per square foot. In planning a new building or addition to an old one, the cost is not calculated on the basis of its cubic contents as is the case in some types of buildings, but is calculated on the basis of the number of looms times 100, which is the amount of space allotted per loom, including aisles.

Appropriations are based on the various factors which make up the cost of the building, reduced to a unit of cost per square foot. In the past such items as motor equipment and wiring for same have been figured on the basis of cost per loom and then divided by 100 which will reduce that to cost per square foot, but for allotting appropriations for lighting no figures have been available which would permit arriving at appropriations for this item. Obviously, the first thing to determine is the intensity required per square foot and then to prepare costs on the basis of the cost per foot-candle per square foot.

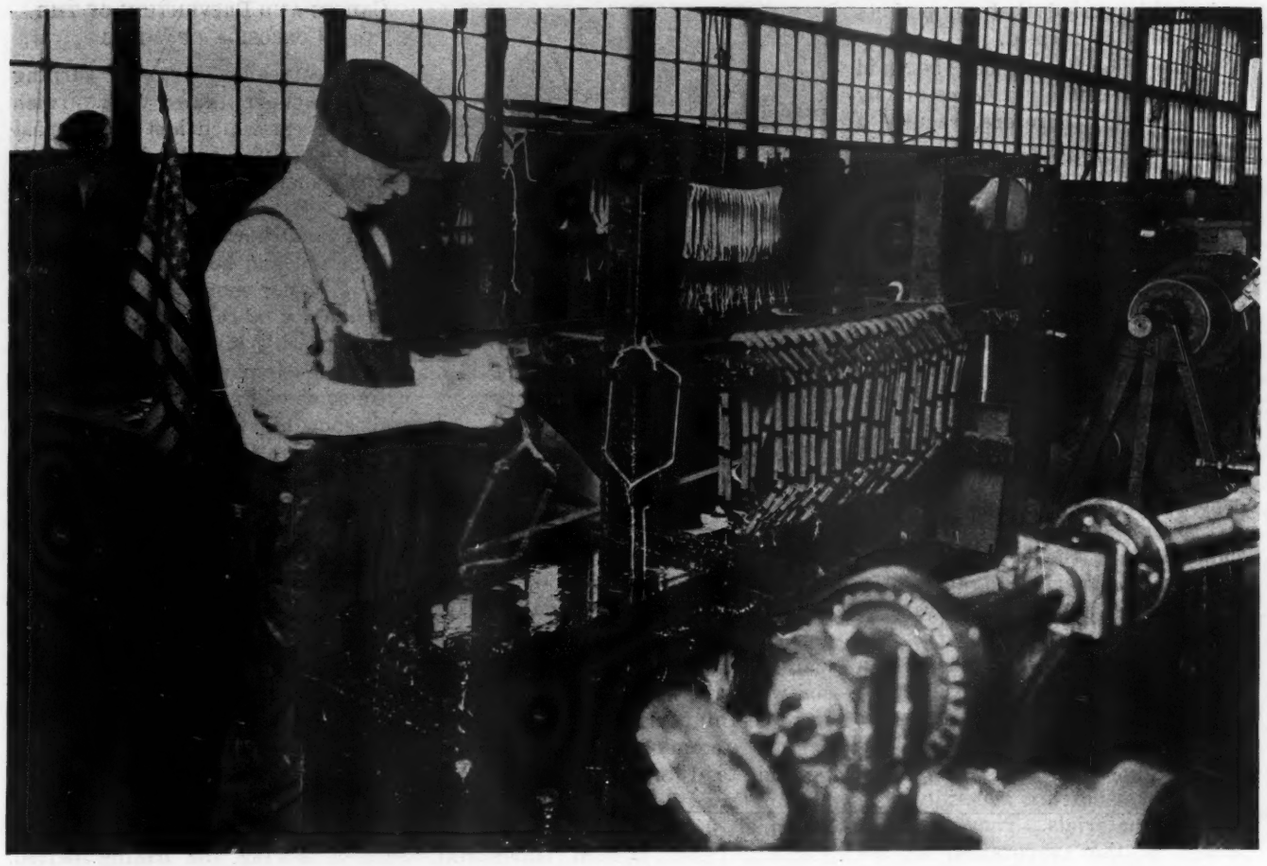
Mr. Tuck's paper was not intended to determine the comparative cost per foot-candle per square foot between various types of lighting units, but was compiled principally as a guide in preparing appropriations or approximate estimates on the cost of lighting installations for various classes of industries and equipment. It was also intended to show that by judicious engineering and by selecting proper reflector equipment that not only will high intensity, low unit-cost installations result, but that systems particularly adapted to the work can be obtained.

In arriving at unit costs it may not seem good reasoning to assume that for non-uniform systems the cost should be figured on the maximum intensity as if it were uniform over the entire area, but the plant executive is not particularly interested in whether the system is uniform or not just so long as he has sufficient light on the work with not too great a ratio between the maximum and minimum intensities. The plant executive paying for lighting is only interested in securing an efficient system of illumination which is so arranged as to be the most useful. If the non-uniform system is best adapted to the requirements it then becomes comparable with a uniform system where it is most desirable in so far as the unit cost is concerned.

Reference to Table I, items 1 and 2, will show that the ratio from maximum to minimum is only 2 to 1, which is accepted as good practice and not objectionable even for a so-called uniform system.

I noticed that Mr. Tuck, in his paper, states that the cost of lamps and labor for wiring and hanging the reflector equipment are staple quantities, the reflector equipment being the only items which may vary. That is true, but the quantity of those staple items will vary with the efficiency or inefficiency of the reflector equipment, because in some instances it is necessary to increase the size of the lamps in order to get the desired result, which increases the number of watts per outlet, and therefore, cuts down the number of outlets per circuit and hence increases the number of circuits.

L. E. Elliott: It is necessary undoubtedly to estimate the cost of lighting on a strictly dollars-and-cents basis for a given room or amount of space. Manufacturers are still thinking of lighting as a wholly one-sided account on the ledger. It is an expense account, and the only thing they are particularly interested in is in keeping it down, so that the red ink balance on the other side may be as small as possible. But from the illuminating engineering standpoint, if we are going to promote better lighting we should look at it from the view point that is really interesting to the manufacturer. The *(Continued on page 356)*



This photograph shows the use of a shallow varnish pan by a large repair shop for dipping small coils of few turns.

Some of the Things to Consider

When Analyzing Coil Insulation Troubles

And Selecting the Best Varnish Treatment—Corrosion Troubles and Treatment for Different Wire Insulations are Outlined in Detail

By H. L. HAZELTINE

Engineer of Insulation, The Sterling Varnish Co., Pittsburgh, Pa.

IN THE ARTICLE that appeared in the June number Mr. Hazeltine outlined the best ways to use insulating varnish to protect windings against moisture, oil, metallic dust, and gave details of the methods of treatment. In this section he takes up a further analysis of insulating troubles and the treatment for enameled wire when used with and without cotton covering. Another section will deal with points to consider when selecting a varnish best suited to the conditions encountered in service.

FROM time to time complaints have been received about the non-drying of insulating varnishes. In general this is simply a case of improper treatment. All varnishes dry from the outside surface towards the center, so that during the initial drying period a skin forms over the outside and tends to retain some solvent and unoxidized varnish in the center of the coil. This really does no harm except that the insulation resistance is somewhat decreased (a good insulating varnish is an insulator, either wet or dry) and that throwing may possibly occur when this undried varnish is in considerable quantity, so that due to centrifugal force in moving parts it breaks through the outer crust and is thrown upon the frame or field coils. No harm may be done, but at the very least it results in a very unsightly appearance.

Baking Varnishes. — Some materials have been sold on the strength of the claim that they will dry from the inside out and that, therefore, drying can be obtained all the way through. These materials have not been a success as it has been definitely proved that they will also form a skin over the outside surface, and when such a skin is formed the oxidation of the varnish base is stopped.

Rather than select a material which must be sold by false claims it is much wiser to see what can be done towards remedying the difficulty by a proper method of treating the coils after the varnish has been applied.

Method.—In order to avoid the accumulation of undried varnish in pockets special attention should be paid to thorough draining; that is placing the coil in such positions

during this period that no pockets can possibly be formed.

Special attention should be paid to the oven. These varnishes dry by oxidation and, therefore, require a considerable quantity of fresh air during the drying period. See that this air supply is properly assured; then see that the proper temperature is being obtained.

Even when careful attention has been paid to these details trouble sometimes occurs, particularly in the case of coils of large cross section in which the thorough drying is hindered by the nature of the insulation, other than varnish, that has been used. In order to prevent the formation of a surface skin in such work many companies reduce the temperature of the oven during the initial baking period to about 150 deg. F. or less and gradually raise it to the desired point during the first two to four hours of the bake. In this way the solvent is evaporated before the actual oxidation of the varnish begins.

Air-Drying Varnishes.—The air drying varnishes are generally non-oxidizing materials. They dry principally by the evaporation of the solvent. Hence, if such a material requires too long a period to dry it is well first to examine the thinner that is being used in the shop. If it is not of the proper grade and contains heavy or slow evaporating fractions it will slow up the drying period amazingly.

If the thinner is the correct one to use attention should then be directed to the thickness of coat that is being applied. The heavy coats, of course, dry slower than do the thin ones. It is much better in such cases to apply several thin films than to try to secure the final results with a single treatment.

The same precautions should be taken to secure good draining as in the case of baking products. If the surface of the material dries so rapidly that the solvent is retained there is no more chance of obtaining thorough drying than if the varnish were left in the can and tightly sealed.

Lack of Color or Covering Quality

Sometimes complaints are received from the small user that the varnish which is being supplied to him gives no "color" or covering to his coils. This is due to one of two causes: Either the material which he is using is composed largely of thinner and does not have sufficient base or useful material to provide the necessary protection or, more generally, it is because in using the material he has thinned it for special work and has either neglected to stir the thinner properly or else he has used too much of it. Proper attention to thinning, such as has been outlined in the article on *Insulating Varnishes and Their Solvents* (March, 1924, issue of INDUSTRIAL ENGINEER) will completely cure any trouble of this sort that may arise in connection with the use of insulating varnishes.

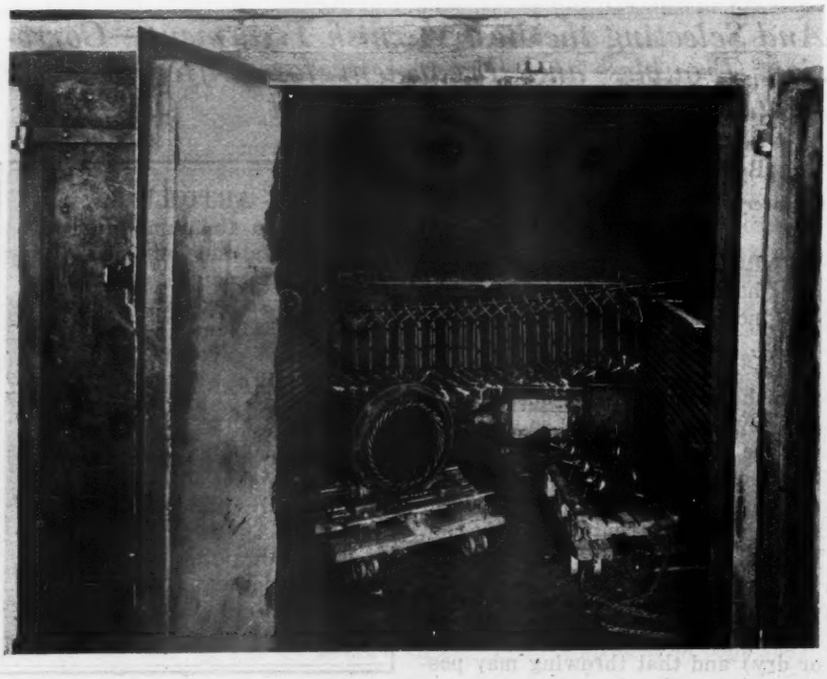
This coil was so badly corroded that it appeared as though green cotton-covered wire had been used.

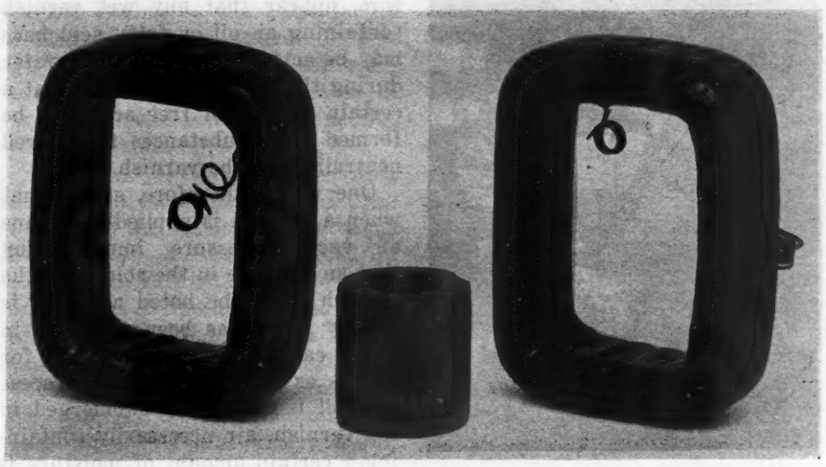
Causes and Prevention of the Corrosion of Wires

The corrosion or the turning green of copper treated with varnish is a problem which has in the past caused more uneasiness in the minds of the user than actual trouble. Most users of varnish know about what to expect and how to guard against this action and hence the subject is one of rather more academic interest than a vital cause of trouble. An article of this kind, however, would hardly be complete if we did not explain some of the causes of verdigris and show just what may be expected of any varnish. Some very excellent engineers have always maintained that the green deposit is a good insulator and therefore could not be the cause of the breakdowns which are sometimes laid at its door. Whether this is true or not it is unsightly and for that reason should be avoided if possible.

Nature of Corrosion.—Corrosion seems to be of two kinds, as evidenced by the turning green of cotton insulation. These are: (*a*) rapid corrosion in which the action becomes visible before the varnish sets or during the baking period. This must be due solely to a chemical action as there is no electrical cause to account for the change. (*b*) Electro-chemical breakdown of the varnish due to leakage or silent discharge which will form ozone or nitric acid if water should be present. This has been shown to be due to faulty insulation design and can readily be distinguished from the

Baking varnishes dry by oxidation. During the baking period fresh air must be provided and the baking temperature regulated so that an outside skin will not be formed too quickly over the surface and stop the oxidation of the varnish base.





Troubles often arise from insulation other than varnish.

In the case of coils of large cross section thorough drying is hindered by the nature of the insulation. To prevent a surface skin in the drying operation, some shops reduce the oven temperature during initial baking to about 150 deg. F. and gradually raise it during the first two to four hours of the bake.

other, which is, therefore, the form of corrosion that most interests us and which we will enalyze.

Cause of Corrosion.—The oil insulating varnishes contain very weak inorganic or vegetable acids. They are present in the oil used but occur in larger amounts in the gums. It is the practice to neutralize these gums and then combine them with the oil by means of heat. It is impossible to neutralize the combination completely because of the danger of saponification and the resulting formation of a water-soluble soap.

The acid content of any varnish is so low and the acid itself is so weak that no action on copper can be observed due to the varnish alone. This can be proven by two simple experiments: (*a*) Take a clean strip of copper and completely immerse it in clear baking varnish. No signs of verdigris will appear whatsoever even after many days. (*b*) Take two clean copper strips and dip one of them in the same varnish. After thoroughly baking allow both strips to stand where they will be exposed to the atmospheric conditions. The untreated copper will after several days show signs of turning green and eventually will be completely covered with verdigris. The one that has been treated with varnish will show no signs whatsoever underneath the film. It would thus appear that not only does an insulating varnish not attack copper but that it actually prevents corrosion.

We must, therefore, look to some source other than varnish for the cause of this chemical action on copper. We are inclined to believe that this is moisture and perhaps oxygen. It seems quite probable when we consider the following experiment: Wind a spiral coil of copper wire about a small diameter rod such as a lead pencil, taking care that the turns do not touch one another. Fasten this vertically to the cork of a small bottle containing a small amount of a liquid varnish, but not enough to touch the wire. Push the cork into place with the spiral inside the bottle. Invert so that the varnish will come in contact with the copper and then place the bottle, right side up, where it will not be disturbed. A drop left on the coil will be found to stretch itself out between turns due to capillary attraction. After a time it will be observed that more or less green has been formed in the drop, indicating that some chemical action is taking place between the copper, wet varnish and air and moisture contained in the bottle. This progresses quite rapidly at first, results showing in from a day to a week, depending upon the varnish chosen for test. It reaches a maximum, however, where no further green appears when the varnish hardens by oxidation and thereafter goes no further. From this test and the two preceding ones several conclusions may be drawn. (1) Some cause other than varnish is responsible for corrosion. (2) This cause is probably oxygen and moisture in the air, since it may be observed in this second test that the maximum varnish and copper surface is exposed to reaction and hence humidity and oxygen are allowed their fullest play. (3) The

It is almost impossible to thoroughly dry a varnish on the inside of a layer wound coil having treated or untreated paper between each layer, by the application of heat from the outside.

The only places for the solvent to escape and for air to enter before the oxidation of the drying coils is through the ends. Another source of difficulty is that some repair men insist on forming coils after varnish treatment. In such a case the rapid baking products dry too hard to permit such an operation. The slow drying materials are sufficiently elastic but the coils are usually warm when they are formed and during this operation the conductors press against each other and may push the insulation softened by the combined action of the heat and varnish solvent. to one side and result in short circuits.

action is stopped when the varnish is completely oxidized.

In other words, just as in the rusting of steel, air and moisture must be present for the formation of verdigris. Copper exposed to air alone turns green in time.

In the second experiment where the copper strip was treated with baking varnish, water and oxygen were unable to get through the impermeable surface film and hence no corrosion was noted. It is further to be observed that enameled wire has never been known to develop verdigris even in coils which have afterwards been only partially dry. The reason can only be that air and moisture have been kept from actual contact with the copper.

Let us next consider the cotton tape or the cotton covering used on magnet wire. There are generally anhydrous acids left in these materials after bleaching. That the material is usually of an acid nature may readily be proved by placing a piece of wet, blue litmus paper upon it. It will turn red showing the presence of acid. Even worse than this, however, is the nap which is always present. These fine hairs allow air and moisture to be drawn through the varnish film which is supposed to cover completely. They also allow the straining out of the varnish by capillary attraction, just as was the case in the spiral and hence the exposure of the maximum copper surface to wet varnish, air and moisture which this nap assists in bringing in. Furthermore, the cotton also contains considerable moisture in itself.

You will now understand better one of the reasons why so much stress was laid earlier in this article upon the necessity for thorough drying of the coils before treatment and the obtaining of a perfect seal over the cotton insulation. Properly treated coils seldom show any signs of a reaction between copper, varnish, moisture and air.

In some shops armatures and stators are wound with white or untreated coils and the complete winding dipped in baking varnish. When this is done some slight degree of moisture resistance is usually sacrificed in order to provide mechanical or binding strength since the purpose of dipping the complete winding is to hold the coils in place and prevent their vibration, to fill all cracks between coils so as to prevent the deposit of dirt or moisture and to seal the laminations and to prevent their vibration, to cover the iron and prevent rust and to protect against oil which may be splashed on windings.

If a coil of copper wire which has been wrapped with cotton and treated with a single coat of a clear baking varnish is cut open considerable verdigris will be found, especially when it has not been preheated, even though practically none appeared when the test was made with the same varnish on the spiral coil in the bottle. It would, therefore, appear that any wet varnish containing an oil or fatty acid base may be acted upon by air and water during the drying period and that a certain amount of free acid may be formed from substances fairly well neutralized in the varnish.

One would, therefore, expect that when a varnish is applied by means of vacuum-pressure impregnation that an increase in the acidity of the varnish would be noted and this is exactly what has been observed in many cases. The explanation for this is as follows: In this process the coil is completely submerged in the varnish, air necessarily containing a certain amount of moisture is admitted over the surface and pressure is applied. This pressure must force the air and moisture into the varnish where it may act upon the varnish itself to cause an increase in acidity, or it may even be driven into the coils where it will come in contact with the copper. The results then would be the same as have been observed in other circumstances. This is one of the reasons why we have not recommended this system for varnish application to coil work.

Let us consider next some of the opinions of others. Some very good authorities claim that the green copper compound formed is an insulator and hence will do no harm. This is probably true for we know of no cases of trouble ever having been actually traced to this type of corrosion. (This does not refer to the electrochemical corrosion which is the result of faulty insulation.) This opinion is also borne out by the opinion of very excellent authorities who claim that the action is not one upon the copper but rather the action of the copper upon the varnish which would probably result in the formation of a copper soap rather than a copper salt.

Some engineers claim that chinawood oil varnishes show less corrosion than do linseed oil products. It is the writer's opinion that this has yet to be proved, although it is quite probable that the action will be arrested more quickly because of the more rapid drying of these materials. As has been stated before, the action ceases as soon as the varnish is thoroughly dry. A linseed oil

After dipping and baking operations, a coat of air-drying varnish is insurance against breaks in the continuity of the baked film.

product drying in the same length of time has been found to give equally good results. On the other hand some of the worst cases of verdigris have been in connection with chinawood oil products.

Measures for Prevention.—Since the varnish makers cannot at present control the action, the user must take it into account. Instead of blaming the varnish he should study his methods of application and so adjust them that the reaction cannot occur. This can be accomplished by preheating the coil thoroughly and then applying a sufficient number of coats to insure against interruptions of continuity. Where the condition is very severe a resort to singeing and sandpapering may help considerably.

Make sure that the varnish used is in good condition and that it contains a sufficient quantity of base or useful material to give good filling and covering to the work in hand. Remember that the larger companies who are doing the most careful work do not have corrosion difficulties. It is more often experienced by those who do not consider varnish of sufficient importance to waste any thought upon it.

Treatment for Enameled Wire

The treatment of coils wound with enameled wire is far from being an academic matter, as was the case of the preceding problem. It is a question which is giving considerable trouble today. As in all of the preceding cases, it can be largely controlled by careful treatment. It is not a thing for which either the varnish maker or the manufacturer of enameled wire can be blamed.

Causes of Softening of Enamel.—The enamel used on copper wire is in all essential respects an insulating varnish baked at a very high temperature. Hence, it will be softened by exactly the same conditions that will cause the softening of a varnish film.

It has been found that all varnish solvents, especially in the presence of heat, have a softening effect upon enamel—some more than others. Such materials as alcohol, acetone and all coal-tar products (such as solvent naphtha) have the greatest effect and hence varnishes containing any one of them in considerable proportions should not be used where they will come in direct contact with enameled wire. Petroleum distillates have the least effect. Varnishes containing a special grade of such products; that is, those which contain a very volatile petroleum distillate of narrow cut—containing none of the heavier fractions—will be found to have the least softening effect upon enameled wire and hence are most suitable for the treatment of coils wound with it.

One source of difficulty has been that some engineers have insisted upon forming their coils after varnish treatment. This is a very grave mistake. The rapid baking products dry too hard to permit such an operation. The slow-drying materials are sufficiently elastic, but the hot solvent remains in contact with the wire for too long a period. Hence the enamel may be softened. The coils are usually warm when they are formed and during this operation the conductors press against one another and may push the insulation, softened by the combined action of heat and varnish solvent, to one side, which will result in short circuits.

Remember that the difficulty is due partly to the nature of the solvent and partly to the length of time which this solvent is in contact with the wire and that this action is hastened by heat. In selecting a varnish for this work one should be chosen which contains a special solvent evaporating so rapidly that it remains in contact with the wire for as short a time as possible.

Process of Treatment.—Two methods of procedure may be followed in handling coils of this type. Either will give good results provided that careful attention is given to the details.

Impregnating Method.—Preheat the coils for a sufficient length of time to drive out the occluded air and moisture from the windings. This time will depend upon the size of the coil. Dip while still hot in a rapid baking varnish of the type described. Allow to remain for at least a half hour or until all bubbling has ceased and the varnish has been drawn into the interstices. Withdraw and drain for at least one hour to allow the varnish to partially set. Then bake at any temperature that will not injure the fibrous insulation, taking care that the bottom during draining is at the top during baking. Repeat this process as many times as are necessary to produce the finish desired. It will generally be found that after the first coat a shorter period of baking may be used, since these later coatings are largely surface films.

The result of this treatment is a well-filled coil with conductors well bound in place to protect them against mechanical strains. As there is little dead air inside the heat generated will be dissipated. The process is entirely suited to the treatment of small armatures wound with plain enameled wire.

The method, however, has this weakness when applied to coils of considerable cross section: During the baking a skin forms over the surface of the varnish and retains a certain amount of wet solvent in contact with the windings which in time will soften the enamel. This is especially true in cases where treated paper is used for layer insulation and in layer-wound coils where the only chance to dry the varnish is through the ends. "Shorts" may show up in such coils many months after they have been in service. Again, where very fine wire has been used the expansion due to heat causes the wire to expand and if it is held too firmly it bursts through the outer insulation.

Coils treated in this manner with the proper type of varnish cannot be formed after treatment.

Quick Dip Method.—Preheat the coil as before. Dip quickly while still hot in a very heavy-bodied, viscous varnish. Allow to remain in the bath for as short a period as possible—a few seconds at the most—withdraw at once and drain thoroughly. Then bake as before with the bottom during draining at the top during baking.

Because of the heavy consistency of the varnish and the quickness of the dip little penetration will be obtained; not over ¼ to ½ in. is desirable. As many additional applications should be made as will give the degree of protection desired.

The resulting coil is completely sealed against moisture, oil, acids, etc. The effect upon the enamel is obviated by the fact that little if any varnish actually comes in contact with the wire. The method is entirely adapted to coils operating on low voltage or intermittent service where little or no heat is generated and hence heat dissipation is not a factor. The process also has the advantage that the coils may be formed, since the conductors are not bound in place and hence have a chance to move.

Still another advantage is that the solvent can be thoroughly dried out without any danger of affecting the enamel. *(Continued on page 354)*

INDUSTRIAL ENGINEER

Devoted to the Maintenance and Operation of Electrical and Associated Mechanical Systems in Mills and Factories

DANIEL H. BRAYMER
Editorial Director

Assisted by

G. A. VAN BRUNT F. E GOODING A. J. WHITCOMB

Chicago, July, 1924

Inexperience Is a Target in Accident Prevention

FROM a study of 201 fatal accidents, the accident prevention committee of the National Electric Light Association in its report presented at Atlantic City last May, points out that nearly one-half of these accidents occurred to men who were inexperienced or new to the conditions under which they were working. Seventy-seven per cent occurred to men during the first five years of service.

These data point emphatically to the need for a periodic and careful check-up on machines, work and surroundings where there is a possibility for carelessness or inexperience to be the cause of a fatal accident. Such accidents, the committee also points out, frequently occur at starting and quitting time, when a competent foreman should always be on the job. At such times carelessness can usually be detected and the responsibility placed where it belongs.

The report mentioned contains thirty-five pages and provides useful information and suggestions to those who are responsible for accident prevention programs.

How Hot Are Your Resistors?

WHEN assuming the responsibility of keeping a drive in continuous operation, one of the first things that the maintenance man looks for is the spare resistors for the control apparatus. In many plants large stacks of spare resistors are a common sight. This is a condition that seemingly should be easily corrected.

Failures of resistors are usually caused by breakage due to vibration, by heating due to overloading and by grounding due to insulation failure. Breakage due to vibration is obvious and the usual motor inspector will correct this trouble without being told. Probably more failures are due to overheating than to any other cause. Overheating with its attendant excessive expansion and contraction of the resistor frames is also one of the most prolific causes of insulation failures.

According to "Standards for Industrial Control Apparatus" adopted May 16, 1924, by the Board of Directors of the American Institute of Electrical Engineers as presented at the annual convention in Chicago last month, and to the "Handbook on Controllers for Electic Motors" issued by the Electric Power Club, the limiting observable temperature rise should not exceed 350 deg. C., when the thermometer is placed in contact with the resistive conductor. In other words with a room temperature of 25 deg. C., a thermometer placed against a resistor grid should not read higher than 375 deg. C. How often is it the case, when walking through a control balcony or control house, to see resistor grids glowing a dull red, in other words working at a temperature around 750 deg. C.? We would not think of putting twice full load continuously on a motor. Why not apply the same thinking toward resistors? The standards mentioned above also specify that the temperature rise of the air issuing from the resistors, when measured one inch from the enclosure, shall not exceed 175 deg. C.

Replacing overloaded resistors with larger capacity resistors and careful determination of the proper size for the initial installation will not only greatly reduce maintenance costs and production delays, but will also reduce the capital investment tied up in non-productive spares.

The Human Nature in Man

IN A recent number of a publication issued by Lockwood, Greene & Company for the purpose of making known in an intimate and personal way the ideals and service rendered by its organization as consulting engineers, and mill-managing and operating engineers, the following item appeared under the heading of "Apple Pie and Golf":

> One thing C. S. Ching of the United States Rubber Company has discovered in dealing with all sorts of men, both big and little, is that no matter how rich they may be, or how high their social position, all of them are human beings.
>
> To illustrate their common humanity, he tells about overhearing the conversation of two boys. One of them said, "Gee, we had a great apple pie at our house last night, and I got a big, juicy piece. I bet you didn't have a pie as good as ours."
>
> "Huh," answered the other boy, "I'll bet your pie wasn't as good as our chocolate cake! I had a big piece of cake with chocolate all over it. I'll bet my piece of cake was better than your old piece of pie."
>
> On the train that same morning in the seat in front of Mr. Ching sat two business men, one the president of a corporation and the other the vice-president of still another big company. The corporation president told his companion how well he had played a certain hole on the Long Island golf course; whereupon the other man came back with a boast about what he had done out on the Westchester-Biltmore course.

After all most people have many things in common—the trouble comes in finding just what these things are. The one that is most common is pride of accomplishment. If a man is doing worth-while things it does not take long to find out what he is most interested in. Plant managers can well take advantage of this trait in human nature, to the benefit of all concerned. Nothing is more gratifying among hard-working foremen than recognition of one or more things they are personally interested in. If it's associated with a company plan of operation no one thing can build up

interest and earnest co-operation in its execution like the enthusiastic support of a foreman. A little recognition once in a while, by the big boss, of a loyal department head or an individual who is doing original and creative work has a peculiar way of paying a large return in the form of advertising the human side of management and the general policies of an institution that make good men like to work for it and induce others of the same kind to join them.

There's a Place for You At the Top

MEN in charge of general maintenance throughout a large plant are about the busiest individuals in the works and they go from one thing to another almost on the run. This is so because they are in many cases trouble doctors, the men to whom others look for fixing up breakdowns, or locating troubles that are holding up work at machines and causing operators to stand around with nothing to do. But when one job is fixed up, on they go to the next and the next from the time they reach the plant in the morning until they leave it at night. After a time they get to know a lot about the weak spots in the plant equipment; the causes of troubles that might be prevented; the carelessness of certain operators, and the ways certain equipment might be changed or rearranged to improve its operation.

Men who have the opportunity of such training and experience and become experts in their work, nowadays have a chance to go up the ladder of responsibility faster than any other skilled mechanic if they possess or acquire one thing—initiative.

Elbert Hubbard once defined initiative as doing the right thing without being told, or at least doing it when you have been told once. It's a little more than this for it's doing a thing right and knowing why; making it your business to make sure that the executive to whom you report knows the details of why things go wrong and presenting the reasons in such a way as to let that individual know that you are interested in preventing troubles as well as curing them; that you have an interest in his problem of production and the elimination of wastes and excessive costs. If you fail to get your point across by talking to him, then write out your suggestions and comments and ask to get the privilege of showing him the things you believe should be done. Just don't give up until you are sure that your viewpoint has been fully understood—that's determination plus initiative and it's the thing every works manager is looking for and willing to pay for when backed by an expert working knowledge of how to do things or get others to do them.

Recently in an eastern plant a maintenance engineer who had been in charge of factory repairs and changes for a number of years was selected as the head of the production division. It came as a surprise to him but it was based upon observation of his work. That man was never contented to do merely routine work in his department but was always ready to help any one by making suggestions and working with him in carrying them out.

He had demonstrated his executive abilities in his own department and knew the technique of maintenance work from start to finish in every other department. Year by year as he went about the plant he absorbed fundamental knowledge of process work, kept in close contact with foremen and their problems and devoted the energies of his staff to giving the best possible service in cutting down delays and preventing troubles.

In his new work his superior feels sure that he will follow the same procedure and combine his experience in maintenance and plant engineering generally with his insight into process requirements. It is a safe bet that the productive efficiency of the entire factory will be put upon a new and higher plane. The ability of this engineer to acquire the mental angle of the production man while going about his regular duties is not unique, but it suggests to other maintenance engineers, who sometimes are tempted to wonder "where they are heading in" when busy with the seemingly endless round of repair jobs required to keep a great industrial organization profitably at work, that the man who gets ahead is the one who goes about his job in the same way as though he owned the whole works and had to meet the payroll every Saturday morning. Such men don't need a pull to get ahead, they need determination, initiative and good health—that's all.

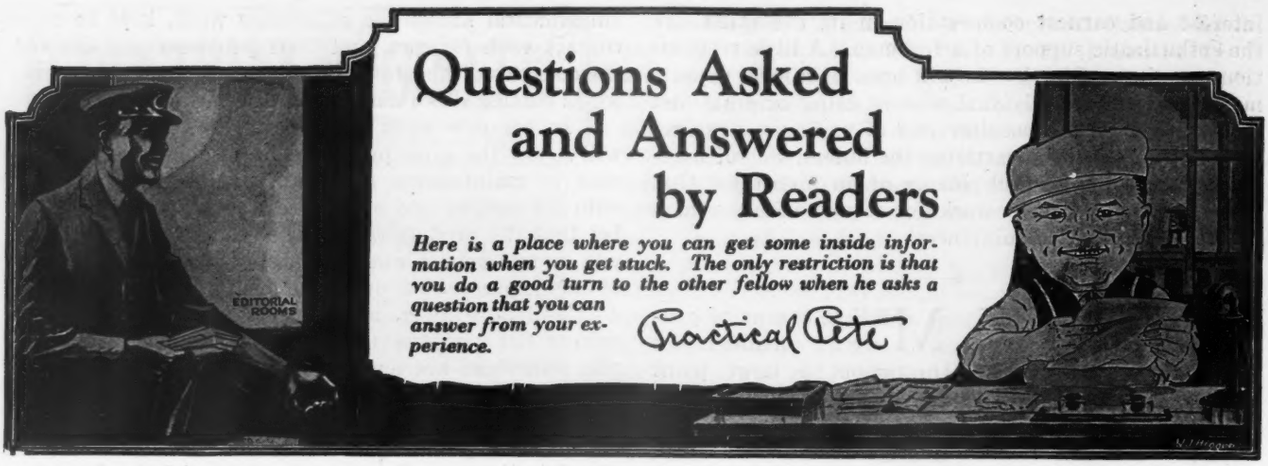
Self Interest Is the Basis of Co-Operation

UNDER the best of conditions the maintenance engineer of a large works has a man-sized job. In addition to the mechanical and electrical problems which must be solved in keeping equipment in proper operating condition, he must manage somehow to secure and keep the co-operation of the various foremen and department heads. Without the co-operation of these men it is very difficult or impossible for the maintenance department to work to the best advantage. The foremen of other departments can do much to help or hinder the work of the maintenance department.

How this co-operation can be secured is a problem to which various answers could be given, and probably no one answer will fit all conditions. Every foreman has his own troubles to worry over and it is perhaps only natural that he should be inclined to pay little attention to the maintenance department and its problems—until one of his motors or machines breaks down. Most of us find it difficult to take much interest in things that we do not know much about, and that do not appear to affect our personal welfare directly.

In an article which begins on page 312 of this issue, Mr. Woodbury tells how the various department foremen of The Wahl Company were led to give their enthusiastic support and co-operation to the work of the maintenance department, through a system of monthly reports which show the charges made against each department. In order to keep some of these charges down to a minimum it is necessary for the foremen to co-operate with the maintenance department in keeping equipment in good condition and preventing breakdowns. Thus, co-operation with the maintenance department becomes a matter of education rather than compulsion or discipline. The foremen can see where maintenance work directly affects their record as executives; it is a useful tool, not a theory or something for the other fellow to worry about.

Securing the co-operation of an individual or a group of individuals is largely a matter of showing what such co-operation will do for them. Self-interest will do the rest, where argument or compulsion might fail.



Questions Asked and Answered by Readers

Here is a place where you can get some inside information when you get stuck. The only restriction is that you do a good turn to the other fellow when he asks a question that you can answer from your experience.

Practical Pete

Who Can Answer These?

Moisture-Proofing Treatment For Motors in Pulp Mills—I wish some of the readers of INDUSTRIAL ENGINEER would tell me what method or treatment they use for keeping moisture out of the windings of motors and other electrical equipment which is located in very damp places, particularly in paper pulp mills. I shall be very grateful for any information you can give me.
Temiskaming, Que., Can. J. H. S.

* * * *

Methods of Repairing Wooden Floors—We have found that the wooden floors in the trucking aisles and particularly at corners where trucks are turned, wear more rapidly than the remainder of the floor. I would like to know the experience of some of the other readers of INDUSTRIAL ENGINEER in making repairs for these sections of the floors. Also, we would like to know whether our readers favor flooring laid parallel to the line of trucking, crossways, or on a diagonal.
Monmouth, Ill. J. H.

* * * *

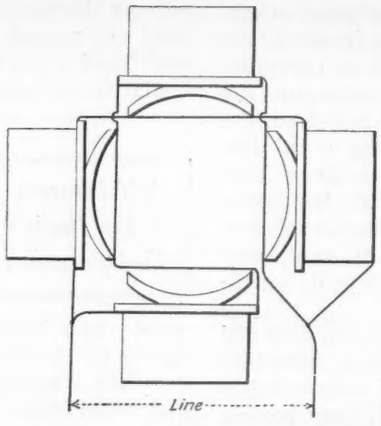
Can Direct Current Be Obtained from Ford Spark Coil?—Will some reader please tell me (1) if I can connect a Ford spark coil to a 110-volt line through a 6-volt, step-down transformer and use it for the ignition system of an engine? (2) Under these circumstances would the high-tension side of the coil deliver a.c. or d.c.? (3) What is the voltage on the high-tension side of one of these coils? (4)Can I put 110 volts a.c. on the high-tension side and charge a storage battery from the low-tension side? (5) Can you tell me how to make a good rectifier for charging storage batteries?
Bellingham, Wash. E. M. D.

* * * *

Construction of Pipe Rails and Guards—We have found it necessary to make some pipe rail guards to extend alongside some of our machines to prevent trucks from getting too close to them and also to provide a free aisle alongside the machines for the operators. As we wish to make these easily removable, I wonder if some of the readers of INDUSTRIAL ENGINEER could offer any suggestions as to how these can be made sectional, the size of pipe to use, kind of fittings, construction of floor sockets, the span between supports, the most convenient length of sections and methods of connecting the sections.
Peoria, Ill. G. G. H.

* * * *

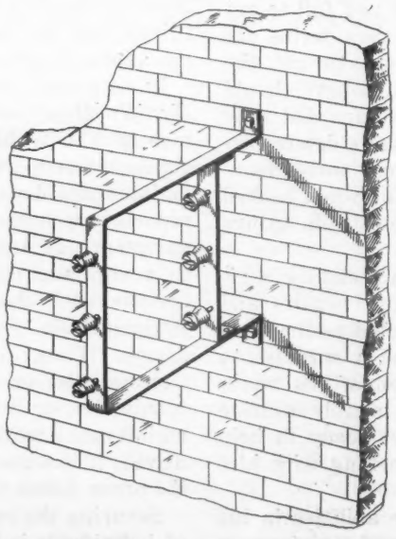
Stator Connections for Old-Type G. E. Fan Motor—I have an old-style, General Electric, 110-115-volt, 60-cycle, single-phase fan motor of the squirrel-cage rotor type, with spool-type stator windings. The original field coils, which were burned out, contained 170 turns of No. 20 d. c. c. wire. As I did not have any No. 20 wire at the time, I rewound the coils with 200 turns of No. 22 d. c. c. wire. Two coils were spool-wound, while two coils were of the honeycomb type. I connected these coils as shown in the diagram. I do



not know what sort of control apparatus was in the base of the fan, but with the connections shown the motor attains a speed of 1,600 r. p. m., but heats up rapidly and would roast out if allowed to run for a time. Will some reader please help me out on this?
Ottawa, Ont., Can. S. J.

* * * *

Will These Brackets Cause Trouble?—I am sending a sketch of an iron bracket which is to be used for supporting two sets of feeders for a three-phase, 550-volt system. Considering that the brackets are made entirely of iron, I should like to know if there would be



any inductive or other action if 20 or 25 of these brackets were used. If so, could it be eliminated by making the brackets of brass or copper? Will someone please advise me what to do?
Hastings-on-Hudson, N. Y. S. S.

Answers Received To Questions Asked

I want to thank the readers who were kind enough to give me so many good answers in the January and April, 1924 issues of INDUSTRIAL ENGINEER, to my question regarding the charging rate of storage batteries. To me these answers were worth the price of my subscription many times over.
Temiskaming, Que., Can. J. H. F.

* * * *

Air Filter for Intake of Air Compressor—I should like to get a little information from someone who may be inclined to lend a helping hand. The plant where I am employed has installed two feather-valve air compressors. These compressors are subjected to coal dust, coal smoke and sand and we are having trouble with the valves. After cleaning them they operate satisfactorily for about 24 hours, and then begin to hang and stick.

Will someone please give me complete details of a suitable screen or air filter that I could make and use on the intake of these compressors?
Norfolk, Va. W. B. E.

We note a question by W. B. E. in the May issue in which information is requested in relation to air filters for compressors. We note that the compressor in question takes in air which is filled with coal dust, sand, etc., and it is quite natural that trouble with the valves would result.

It would be our recommendation that the reader install an air filter on the suction of these machines, and we can refer him to the Reed Engineering Company of 50 Church Street, New York, who would be glad to furnish such filter.

Your client should give the Reed Engineering Company full information regarding the capacity of the machine and size of suction opening.

We are sending you two copies of this letter so that you may forward one to your client if you so desire.

R. D. BROOKS.
Manager, Air Compressor Dept.,
Worthington Pump & Machinery Corp.,
New York, N. Y.

* * * *

In reply to the inquiry by W. B. E. in the May issue of INDUSTRIAL ENGINEER, in regard to air filter for intake of air compressor, I would refer you to bulletin T-3516-2 put out by the Westinghouse Traction Brake Company, Pittsburgh, Pa., showing centrifugal dirt collectors and strainers.

Perhaps there is something in this which will help you out in your dif-

ficulty. On the street cars, we use a strainer similar to that shown on page 5, piece No. 67900, and find that we have very little trouble with dirt or dust in the compressor. However, the curled hair should be removed from the strainer and washed thoroughly in gasoline at regular periods.

Asst. Supt. of Equipment. R. S. NEAL.
The Kansas City Railways Co.,
Kansas City, Mo.

* * * *

Correcting Power Factor by Synchronous Condenser—I wish to submit the following problem to our readers: *A* is a distributing station supplying power to four feeders, *B*, *C*, *D* and *E*; *B* takes 4,000 kw., *C*, 3,500 kw., *D*, 3,000 kw., and *E*, 2,000 kw. The power factor of these loads is: *B*, 80 per cent, *C*, 78 per cent, *D* 75 per cent and *E*, 72 per cent, all lagging. It is desired to install a synchronous condenser at station *C*, to give 95 per cent power factor. Would it make any difference in the size of condenser required at *C* if stations *B*, *D*, and *E* were to correct their power factor to unity instead of running at 80, 75 and 72 per cent respectively, as at present, (1) in case station *A* has ample generator and exciter capacity and (2) in case this capacity is just enough to carry the load?
Belleville, Ont., Can. J. H. G.

In looking over my reply, in the May issue, to J. H. G.'s question I find that I made an error in my answer. I evidently copied the wrong value for the synchronous condenser and gave the reactive kva. instead of the actual condenser capacity, which should have been 6,300 kva. The second paragraph of my answer should, therefore, read: "(1) Under the first set of conditions, to raise the power factor to 95 would require a synchronous condenser with a capacity of 6,300 kva., operating at zero power factor leading," etc. The value of 1,000 kva. given under Case 2 is correct.

I regret that this error was made and want to take this opportunity of correcting it. C. OTTO VON DANNENBERG.
The J. G. White Engineering Corp.,
New York, N. Y.

* * * *

With reference to the problem submitted by J. H. G. in a recent issue of INDUSTRIAL ENGINEER, it is evident that power factor correction is desired at station (A), as a condenser at station (C) will only affect the power factor in the line between stations (A) and (C) and on the bus bars and generating equipment at station (A).

Considering the correction of power factor at station (A) by a condenser at station (C), assume that the diagram is drawn to scale, letting the ordinates (vertical lines) represent wattless inductive kva., the abscissas (horizontal lines) represent kw. and the diagonals (hypothenuses) the total kva. of the various stations as follows:

Station (B); (ab) equals 4,000 kw.; (bc) equals 3,000 wattless lagging kva.; (ac) equals 5,000 kva. delivered to station at 80 per cent power factor.

Station (C); (cd) equals 3,500 kw.; (de) equals 2,800 wattless lagging kva.; (ce) equals 4,500 kva. delivered to station at 78 per cent power factor.

Station (D); (ef) equals 3,000 kw.; (fg) equals 2,640 wattless lagging kva.; (eg) equals 4,000 kva. delivered to station at 75 per cent power factor.

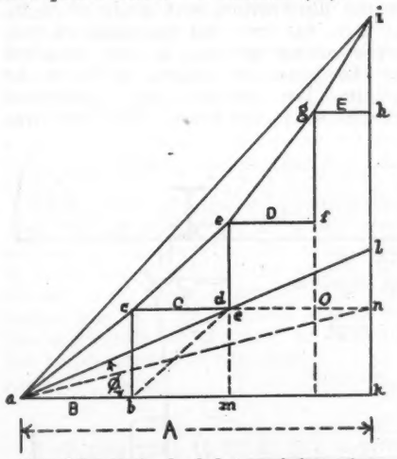
Station (E); (gh) equals 2,000 kw.; (hi) equals 1,930 wattless lagging kva.; (gi) equals 2,780 kva. delivered to station at 72 per cent power factor.

Station (A); (ak) equals 12,500 kw. output; (ki) equals 10,370 wattless lagging kva.; (ai) equals 13,160 kva., total delivered by station. Power factor equals (ak) divided by (ai), or 77 per cent.

If (al) be drawn so that cos Φ equals 0.95, the line (al) will represent the kva. at station (A) when delivering 12,500 kw. at 95 per cent power factor. Then (kl) will represent the wattless lagging kva. at the same time. Line (il) will represent the leading power factor required to correct the power factor at station (A) to 95 per cent. The size of condenser, as indicated by this line, will be approximately, 6,240 kva, when operated at zero leading power factor.

Placing a condenser of this capacity at station (C) will change its power factor from 78 per cent lagging to approximately 48.6 per cent leading and would cause a wattless load in its feeders considerably in excess of the value before correction.

Referring to the diagram, if stations (B), (D) and (E) are raised to 100 per cent power factor, (ab) equals 4,000 kw. at (B) at 100 per cent power factor; (bm) equals 3,000 kw. at station (C) at 78 per cent power factor; then (me') equals 2,800 wattless lagging kva. at (C); (be') equals 4,500 kva. delivered to station (C); (e'o) equals 3,000 kw. at (D) at 100 per cent power factor; (on) equals 2,000 kw. at (E) at 100 per cent power factor; (an) equals 12,800 kva. output at station (A). Power factor equals (ak) divided by (an), or 97.6 per cent power factor at station (A).



Graphic method of determining size of condenser needed for power factor correction.

Since the power factor under this condition is 97.6 per cent no condenser is required at (C).

The diagram was purposely distorted to show more clearly the method used and it should not be scaled to verify the above figures.

In the writer's opinion, a condenser is not warranted in this instance, but if the main station is loaded to such a capacity that it should be considered, the money necessary to purchase the condensing equipment could be better applied to additional power plant equipment. If the generator has sufficient capacity, there is no need to worry.
Wilmington, N. C. CHARLES R. SUGG.

Supporting Load from Concrete Ceiling—In rearrangement of the plant with which I am connected, we frequently find it necessary to suspend conveyors, motor platforms, countershafts, heavy radiators, and similar equipment from the ceiling of a reinforced concrete building. I am wondering if any of the readers of INDUSTRIAL ENGINEER have any information on how heavy a load can be supported from expanded bolts. I would also like to find out what other readers consider the best method of fastening equipment to the ceiling.
Chicago, Ill. E. D. F.

Referring to E. D. F.'s inquiry in the April issue, by far the cheapest and easiest way to attach a heavy load to a concrete ceiling is to drill right through it and screw bolts into flat plates. If desired the plates can be sunk below the level of the floor above and a concrete patch put in.

Of course, if the ceiling is the roof, it will be necessary to make the job water tight, but there are plenty of roofing compounds which can do that.
Plainfield, N. J. CHESTER L. SEYMOUR.

* * * *

In answer to E. D. F.'s question in the April issue, the literature on the holding power of expansion bolts set in concrete is quite limited. Merriman, in his "American Civil Engineer's Pocketbook," third edition, page 591, states that expansion bolts, when imbedded in 1:2 portland mortar, have an ultimate holding power of 264 lb. per sq. in., and adds that a working unit stress of about one-fifth of this, or 53 lb. per sq. in. should be used.

Turneaure and Maurer in their "Principles of Reinforced Concrete Construction," second edition, page 216, state that the bond strength of plain steel is 200 to 250 lb. per sq. in., from which a working stress of 60 to 80 lb. per sq. in. is suitable. They further state "For deformed bars having a positive grip, a working stress of 150 lb. per sq. in. gives an ample margin of safety."

Let us apply this to a particular brand of ½-in. bolt and anchor. Roughly, the anchor is 1 in. in diameter and 2 in. long, making an area of 6.28 sq. in. imbedded in concrete. At 150 lb. per. sq. in. this would give a holding power of 942 lb. Allowing 10,000 lb. per sq. in. tensile strength in the bolt, which ought not to be exceeded, a ½-in. bolt is good for 1,260 lb. in tension. This would show that, for this particular case, the anchor would be weaker than the bolt.

There are a number of types of expansion shields on the market, ranging in size from those for small wood screws to those for 1-in. bolts. Each manufacturer claims that his particular product is the best and asserts that when properly applied the bolt will break before the anchor pulls out. This may be true in all cases where properly installed, but unless the workman is thoroughly familiar with this class of work, the shields will not be properly installed. This is especially true of the malleable and composition anchors on the market. Proper drill size is absolutely necessary for the correct installation of these anchors.

The "Pierce" lead sleeve expansion bolt comes in sizes of ¼ in., ⅜ in., and ½ in. and of varying lengths and has been found to be very effective in these sizes. For bolts larger than ½ in., mal-

leable anchors of either the "Sebco" type or the "Keystone" type have been used here with success. The latter has been used to support 1-ton trolley tracks mounted on a concrete ceiling.

Practically, I should hesitate to depend upon an anchor's developing the same strength as its bolt and, to allow for poor workmanship, would say that no anchor should be called upon to develop more than one-half of the working strength of the bolt.

Fort Worden, Wash. E. I. PEASE.

* * * *

Answering E. D. F.'s question in the April issue, expansion bolts used for overhead loads on a concrete ceiling are safe only for small areas and not very heavy loads, and where serious vibration is absent. The safest way to suspend heavy loads is to use strong split clamps bolted to I-beams. If the beams cannot readily be located in the ceiling at all points, light rails or small I-beams can often be supported from such beams as can be located. Then countershafts, platforms, etc., can be readily clamped to the exterior I-beams.

Expansion bolts are likely to crack out pieces of the concrete ceiling if drawn up too tightly, and if left a trifle loose they are liable to work out. The only safe fastening for a heavy overhead load is clamps on the flanges of beams, or bolts in drilled holes, with lock washers or double nuts.

By the methods shown in the illustration the writer has supported motors up to 1,000 lb. in weight on exterior I-beams bolted to the beams imbedded in the ceiling. If the span is very great use heavier beams to support the loads, and as many as are needed may be placed side by side.

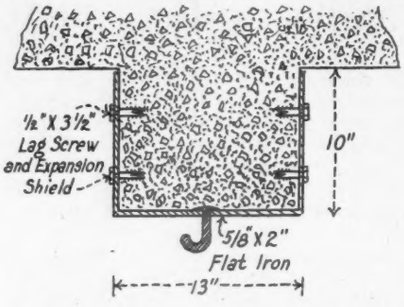
Expansion bolts are all right in concrete floors and for some kinds of light, motionless loads on side walls, but for heavy loads on walls and ceilings they are not to be trusted, principally because they are liable to work loose, no matter how long or what type they are.

New Britain, Conn. H. S. RICH.

* * * *

Referring to E. D. F.'s question in the April issue, I have had to solve this same problem and finally made a strap or detail which has given very satisfactory results. This strap, which is shown in the illustration, was made of ⅝-in. by 2-in. flat iron and was used on concrete ceiling beams. It was attached to the beam by means of ½-in. by 3½-in. lag screws and expansion shields set in the beam. The hook was made from a piece of ⅝-in. round iron. The upper end of the hook was peened over so that the strap would fit close to the beam. I might suggest that if this hooked strap, as shown, is undesirable holes may be drilled and tapped for bolting any type of support to the strap. I sincerely hope that E. D. F. will find this strap to be the solution of his problem.

Dallas, Tex. F. J. H. KRAUSE.



A flat iron strap fastened around the beam by lag screws and expansion shields and fitted with a hook forms a convenient support for heavy weights.

* * * *

Installing Signal Lamp on Single-Phase Electric Furnace—Can any of our readers tell me how to install a signal lamp on a single-phase electric furnace?

There is a switch on the primary side of the transformer that furnishes current for the furnace, and I wish to find some way of installing a light between the top carbon electrode and the bottom contact, so that when the switch is released by a short circuit from a piece of metal falling against the carbon electrode, we can tell by this light whether the electrode has been raised high enough to break contact with the metal, before throwing in the switch.

The winding in the transformer forms a permanent circuit, so that we cannot apply any outside source of current to operate this light. It would save us considerable money if we were able to connect up a light of this kind, as the cost of carbon electrodes and contacts for the switch runs into considerable money. I shall appreciate very much any suggestions which you can give me.

Michigan City, Ind. P. V. H.

Answering the question by P. V. H. in the March issue, inasmuch as the winding in the transformer forms a permanent circuit, there seems to be no way to attach a lamp circuit to the electrodes without cutting in on the secondary. If it would save considerable money to have such an indicator I would suggest cutting in a heavy, double-throw, double-pole knife switch, which would disconnect the transformer secondary circuit and at the same time connect in an outside lighting circuit. The indicator should consist of at least two lamps, so that no delay would be caused if one should burn out.

New Britain, Conn. H. S. RICH.

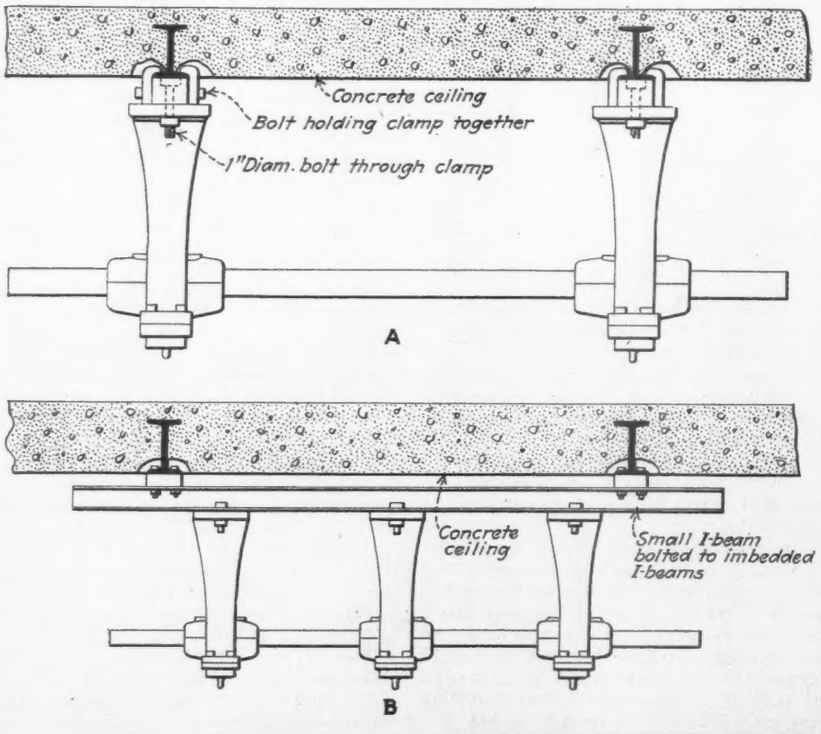
* * * *

Trouble with Single-Phase Motor—I have a ⅓-hp., 110-volt, 60-cycle, single-phase induction motor of the split-phase starting type, having its windings on the rotor and the squirrel cage on the stator. This motor recently showed evidence of heating when running on light load and finally refused to start, even without load. On testing the windings, they were found to be free from opens, shorts and grounds. The centrifugal switch functions all right but shows burning at the contact points. The bearings were renewed and the contact points cleaned, after which the motor started on no-load when first reassembled, but after that it again refused to run. The rotor was free in the bearings and did not rub on the stator, also the brushes were operating all right. Will someone suggest what may be the cause of the trouble?

Newark, N. J. H. M.

In reply to H. M.'s question in the May issue, I am inclined to think that his trouble is in the stator, assuming the motor tests were correctly made and no defects found. Troubles in rotors of induction motors are not particularly common. H. M.'s motor may have been running at times with a temperature high enough to melt the solder at the joints of the bars and short-circuiting ring. High resistance at the loose joints might have caused the motor to heat sufficiently for this to happen.

Loose joints manifest themselves by



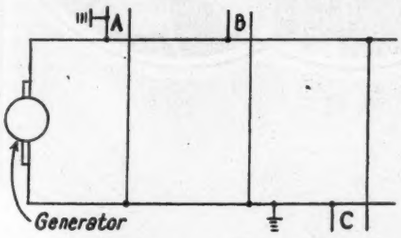
Heavy loads may be suspended from the ceiling by split clamps around the beams, (A), or from I-beams bolted to the ceiling beams, (B).

a rattling noise, in the case of a squirrel-cage motor. Inasmuch as his motor has the squirrel cage on the stator the rattling noise mentioned above is not very noticeable.

New Orleans, La. OVIDE C. HARRIS.

* * * *

Why Do Grounds Not Blow Fuses in Power House?—It always takes two grounds of opposite polarity to make a short circuit. In cities or in large industrial plants where there is much conduit work, there must be grounds. If there is a ground on the negative side of one building and a ground on the positive side of another, why would these not blow the main fuse or open the breaker in the power house? Again, under the conditions shown in the diagram, when testing out building *C*, would it not be possible to obtain results which would make one think that there is a ground somewhere in this building whereas it is located in building *A* or *B*?



Worcester, Mass. F. R. B.

In reply to F. R. B.'s question in the April issue, I would say that the fuses do not blow nor the breakers open because the short circuit is of very high resistance. The current is not strong enough to open the circuit. However, it represents a power waste even though it does not interrupt service.

It is possible to obtain the results you mention. In a case like this it is always advisable to open the entrance switch and thus eliminate the danger of picking up a ground from another part of the circuit. This might lead to a good deal of confusion and loss of time before the real situation was discovered and corrected.

SGT. JAMES A. COOKE.
Observation Battery,
Fort Bragg, N. C.

* * * *

In reply to F. R. B.'s question in the April issue, with two grounds on the opposite polarity of a system, the main fuse will blow or the main circuit breaker will open only if the resistance between the grounds is low enough to allow sufficient current to pass through to trip the circuit breaker or blow the fuse.

If the grounds have a high resistance, as when they are due to dampened, worn insulation, or through dust or some partially conducting medium, it is doubtful whether any effect will be noted, other than an indication on the ground detector. Should the voltage be high enough and sufficient current flow through the conducting medium to the ground, it is possible that there might be local heating, or even danger of fire if the surrounding conditions are favorable.

It is the practice of some companies to make tests to determine the resistance of grounds even to the extent of using various sizes of fuses to blow under certain conditions.

When testing for grounds in certain buildings, the existence of a ground in a particular building can only be definitely determined by opening the main supply switch to that particular building and then making tests. A ground on other parts of the system or in any other building will lead to confusion regarding the particular location of the ground when the whole system is interconnected.

When the whole system is installed in iron conduit or in lead-covered cables, grounds on opposite polarities will usually have a sufficiently low resistance to give a definite action of the fuses or circuit breakers.

C. OTTO VON DANNENBERG.
The J. G. White Engineering Corp.,
New York, N. Y.

* * * *

Answering F. R. B.'s question in the April issue, where the ground appears on both sides of the line in separate buildings there is enough resistance in the earth to keep the fuses from blowing or the circuit breakers from opening, and yet the ground indicator at the power station will indicate the heavier ground. This is a common occurrence on d.c. circuits where motors are used mostly for operating elevators or other apparatus and are placed in damp basements.

It is not possible for both grounds to show in the same building. When testing for a ground the heavy ground will show on the test lamps until it is removed; then the ground will show on the other side of the line. Upon pulling the main switch of that building the ground will show up on the main outside circuit, and can easily be traced to the other building.

I have found that the best way to test for this kind of a ground is to use test lamps, connecting enough lamps in series to carry the voltage, and making a test at the cabinet center by cutting out each circuit and testing for the ground.

Time is often saved by pulling the main switch of the building and then testing for the ground. One must keep in mind which side of the circuit the ground is on because, as before stated, indications of a ground will appear on the other side of the line as soon as the heavy ground is removed.

Knoxville, Tenn. W. P. AMANNS.

* * * *

With reference to F. R. B.'s inquiry in the April issue, a discussion of why main circuit breakers do not open due to grounds on both sides of the line involves several points.

(1) If the grounds do not appear on the same machine, there is an appreciable resistance between them which limits the current. The writer measured the resistance from a water pipe to the angle iron supporting a switchboard, 20 ft. distant. The angle iron was fastened by expanding bolts to the concrete floor, which was laid directly on the ground. The actual resistance was 50 ohms. This resistance, on our 220-volt lines, would permit a flow of 4.4 amp. if both legs were solidly grounded.

(2) In a properly designed system the main feeders are better insulated and as they carry more current than the smaller branch circuits, the lines are fused accordingly. Assume that the main distribution panel is fused for 600 amp.

One feeder circuit goes to an individual building panel where we find the circuit split and the main fuse on that board to be 150 amp. These branches are distributed to various lighting circuits and machines with their individual fuses of 20, 40, or 60 amp. rating. As grounds appear most frequently at the machine, the smallest fuses would be the first to go and thereby protect the main circuits.

(3) If all circuits are periodically inspected, using a megohmer to test the insulation resistance and these tests are tabulated, deterioration can be watched and checked before any damage is done.

As to the location of the grounds, we always pull the switches or fuses of each building when testing for grounds. One bad spot, therefore, appears only in the building which is being tested at the time.

If the circuits must be tested while they are hot, there is on the market a patented ground locater for running down the ground without any possibility of error. By listening in with an ear phone at different points along the feeder, a sound is heard only at those points where ground current is passing through the copper tested. As soon as the grounded machine is passed, the phone is silent. In this manner, grounds can be traced with certainty down any number of branches.

CHESTER L. SEYMOUR,
Plainfield, N. J.

* * * *

Preventing Corrosion of Iron Storage Battery Racks—I should like to ask your readers what treatment can be given to iron racks for storage batteries which will prevent the spilled acid from attacking the iron. We use the lead type of battery filled with dilute sulphuric acid. We have a large number of storage batteries and recently some iron racks have been constructed. All of these racks were painted with several coats of the best grade of asphaltum black paint but this does not protect the iron when acid is spilled on it, nor does any kind of paint that I have tried.

We have had considerable trouble due to the corrosive effect of the acid forming a substance resembling sand which falls into the jars below. This produces excessive iron in the solution, making a change of acid necessary. I shall appreciate it if anyone can tell me how to overcome this.

Atlanta, Ga. J. B.

In reply to J. B.'s question in a recent issue, as the result of experimenting with several different preparations in an effort to prevent corrosion of battery racks and busbars I would suggest that he thoroughly clean off all old paint and corrosion from the attacked parts and then wash them with a solution of bicarbonate of soda. Dry thoroughly and apply two coats of Pyramid Acid Resistor Paint, either flat or gloss, or both.

If he does this I am sure that the trouble from corrosion will disappear. I have experienced J. B.'s trouble and I sympathize with him. It is very annoying and hard to overcome.

The Pyramid paint I mentioned can be obtained from the Pyramid Paint Co., Philadelphia, Pa.

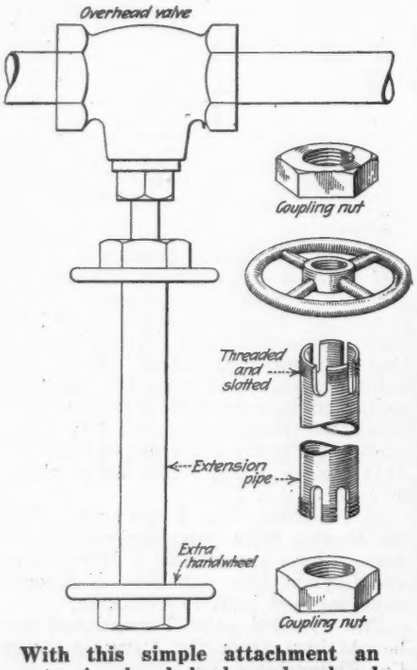
Dallas, Tex. F. J. H. KRAUSE.

Building Maintenance and Plant Safety

The object of this department is to give details of building maintenance procedure and best practice in safety work. Articles on ways of handling natural wear and tear or other depreciation, repair methods, rebuilding, extensions, cleaning and painting operations will always be welcome.

Simple Extension for Lengthening the Valve Stem for Convenience in Control

PRACTICALLY every operating man has found instances where those responsible for the construction of the plant have placed valves and other similar equipment in places difficult of access or almost unbearable because of the heat or wet, and in some instances even in locations dangerous because of proximity to moving parts of machinery. Sometimes these difficulties may be overcome by building platforms or using ladders. To change the location of such a valve is often expensive and may require the temporary shutting down of a section or all of a plant. Even though these valves may be operated infrequently a delay incidental to an emergency operation, because of the difficulty of access, may be serious.



With this simple attachment an extension handwheel can be placed on valves which are located in places difficult of access.

One way of operating such valves is by means of the easily-constructed extension handwheel shown in the accompanying sketch. This extension is made from a length of pipe, threaded and slotted on each end, as shown in the detailed drawing, to go over the spokes of the handwheels. The extension pipe is secured, both to the valve handwheel and the added handwheel, with two coupling nuts. In case these nuts are not available, two pipe caps can be used but the one to be placed at the valve must be drilled out to go over the stem.

This is an easily-made fixture which it is possible to construct in a short time, in almost any shop, without any special facilities other than pipe tools. With an extension such as this a valve may be operated from either side of a wall.

Washington, D. C. G. A. LUERS.

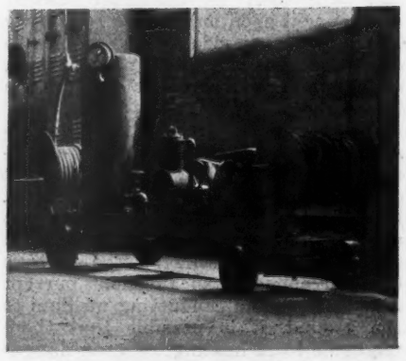
Constructing a Portable Air Compressor for Supplying Air in Isolated Locations

EXTENDING the piping system so as to place compressed air outlets convenient to all motors in and around a large industrial plant usually means a prohibitively heavy expenditure, unless there are other uses for the air at those locations. Also, where the compressor is supplying various tools, suction boxes and other equipment, an extra supply of air is not always available when needed for blowing out foreign material from motors. It often happens, too, that the general air supply is rich in moisture which may do as much harm to the motors as the dust would, if it were allowed to remain.

An economical portable compressor, as shown in the accompanying illustration, was built by the writer and has given entire satisfaction. A small compressor, originally used on the sprinkler system, was mounted on the truck which was built for the purpose, and connected to a tank made from a 3-ft. length of 12-in. heavy wrought-iron pipe, the two ends of which were sheeted and welded. This tank withstood a pressure of 150 lb., and was provided with a gage and pop valve set at 120 lb.

The motor used is a spare 5-hp., 550-volt, three-phase, 1,800 r.p.m. induction motor which, while about three times too large for the compressor, did not add to the cost of the outfit as it could be used in other places and also serve as a spare.

Two reels were mounted on the truck, one with 150 ft. of ½-in. hose and the other 250 ft. of four-conductor cable. The ends of the cable were fitted with universal test clips so that 550 volts could be obtained easily from any service station around the plant. This gives a working range of practically the whole plant and yard as compressed air can be supplied at practically 400 ft. from the electrical power outlet.



This portable compressor is used to supply compressed air in isolated locations.

Often, all parts of a plant are not provided with compressed air pipes. This portable compressor was made up of miscellaneous spare equipment at one plant and provided with 250 ft. of cable and 150 ft. of air hose which would give it a range of almost 400 ft., from any power outlet.

When this equipment is being used to blow out equipment two men can easily handle the outfit and do more work than is possible with the air outlet system. H. E. STAFFORD.

Electrical Engineer,
Port Arthur, Ontario, Canada.

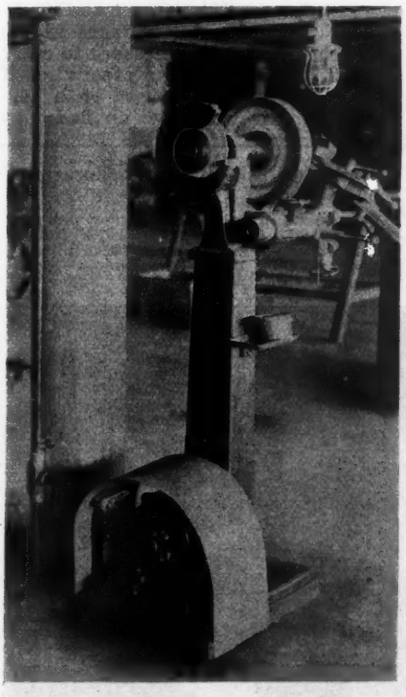
[EDITOR'S NOTE: To prevent the force of the blast from rupturing the insulation, it might be well to use some method of reducing the pressure before applying it directly to motors. If blowing out motors is the only use for this portable outfit, a hand blower with extension cord might be used much more economically. Other applications, however, of a portable compressor of this sort might be for operating drills, hammers or other tools in isolated locations or other places which are not piped with air. It could also be used for general cleaning or with a paint spray.]

Inexpensive Guard for Motor of Direct-Driven Grinder

AN UNUSUALLY simple but flexible motor guard for a vertical grinder unit was made up in a Massachusetts factory by bending a piece of sheet iron over the top of the motor, as shown in the illustration. A slot in the side of the guard next to the adjacent column permits the entrance of the conduit feed line. The guard is held in place by screwing it to the wooden base on which the grinder is mounted. This guard is strong, but easily removed when necessary and, as will be seen, gives ample protection to the motor and wiring.

This shield not only protects the motor from water dripping but also prevents abrasive material from getting into the bearings. Another possible source of trouble guarded against is particles of steel getting into the windings and causing grounds or shorts.

Boston, Mass. H. S. KNOWLTON.



A piece of sheet metal was bent into the form of a semi-circle and fastened in place over the motor by screwing it into the wooden base on which the grinder is mounted.

Procedure for Refinishing of Heavy Machinery

IT IS often necessary or desirable to refinish large generators, motors, engines and other equipment. Refinishing is not a particularly difficult process, but unless certain precautions are observed and the work as a whole carefully done the results are likely to be disappointing. The following instructions, which we have used with good results, may therefore be of interest to the readers of INDUSTRIAL ENGINEER.

(1) *Finishing a Machine Completely.*—When putting an entire new finish on a machine or piece of apparatus in a plant, the following procedure shall apply:

(*a*) Scrape the machine thoroughly to remove all traces of the old filler and enamel. Wash the machine with gasoline, or carbon tetrachloride, if available, to remove all traces of oil. The surface of the ironwork must be entirely free from oil before the filler is applied.

(*b*) Apply one coat of brush filler. This filler is prepared by thinning Degraco Filler Paste Color No. 52, grey, to a brushing consistency with turpentine. Allow one hour for this coat to dry.

(*c*) Fill in all rough spots and holes using the filler as it comes from the can. Before proceeding further the machine should be allowed to dry at least twelve hours.

(*d*) Reduce some of the filler to a semi-paste with turpentine and smooth out all irregularities with a knife. After getting the surface as smooth as possible follow up immediately with a coat of brush filler as under (*b*). It is best to knife a small area, say a square foot or two, and then go over this spot with the brush filler, rather than knife the whole machine before brushing it over.

(*e*) Give a final complete coat of brush filler and allow to dry twelve hours.

(*f*) Rub down very carefully with sandpaper starting with No. 1 and finishing with No. 00. Procure a piece of smooth soft leather and finish the filler down to a perfectly smooth surface.

(*g*) Before proceeding to apply the machine enamel, paint the armature, field coils, armature spider, pole faces, cables, etc., with Westinghouse Air Drying Insulator Varnish.

(*h*) Apply a coat of Degraco Machinery Enamel Color No. 118, yellow ochre, and allow time to dry.

(*i*) When thoroughly dry go over the machine carefully and note any spots that are not perfectly smooth and glossy. Work these down with No. 00 sandpaper, being careful not to remove the enamel entirely.

(*j*) Apply final coat of enamel to the machine, being careful to brush out smoothly and evenly leaving no brush or finger marks. While putting on this coat and during the time it is drying, be very careful not to allow dust to settle on the surface. Avoid all sweeping and if possible keep the room closed. As a precaution it is a good plan to make a screen to put over and around the machine, where possible.

(*k*) During the whole process of finishing do not permit any oil to get on the machine as it will prevent the proper adherence of the filler and enamel.

(2) *Retouching Finish on a Machine.*—When retouching the finish on a machine that has been re-assembled after repairs or on which the finish is damaged from other causes, the following procedure shall apply:

(*a*) Sandpaper with No. 1 paper the parts affected, to remove all loose or cracked particles of filler or enamel.

(*b*) Brush or knife in filler according to the nature of the damage, giving two coats and allowing about ten minutes between them.

(*c*) When thoroughly dry smooth down carefully and sandpaper starting with No. 1 and finishing with No. 00. Give a final rub down with leather.

(*d*) Apply a coat of enamel and let dry over night.

(*e*) Apply final coat of enamel observing precautions noted above under (1) *k*.

By the use of these instructions it is easy to standardize the refinishing of machinery. I have found that if the operations outlined are carefully performed a very satisfactory finish will be obtained. FREDERICK KRUG.

Comerio Falls,
Bayamon, Porto Rico.

Effective Method of Cleaning Windows and Skylights

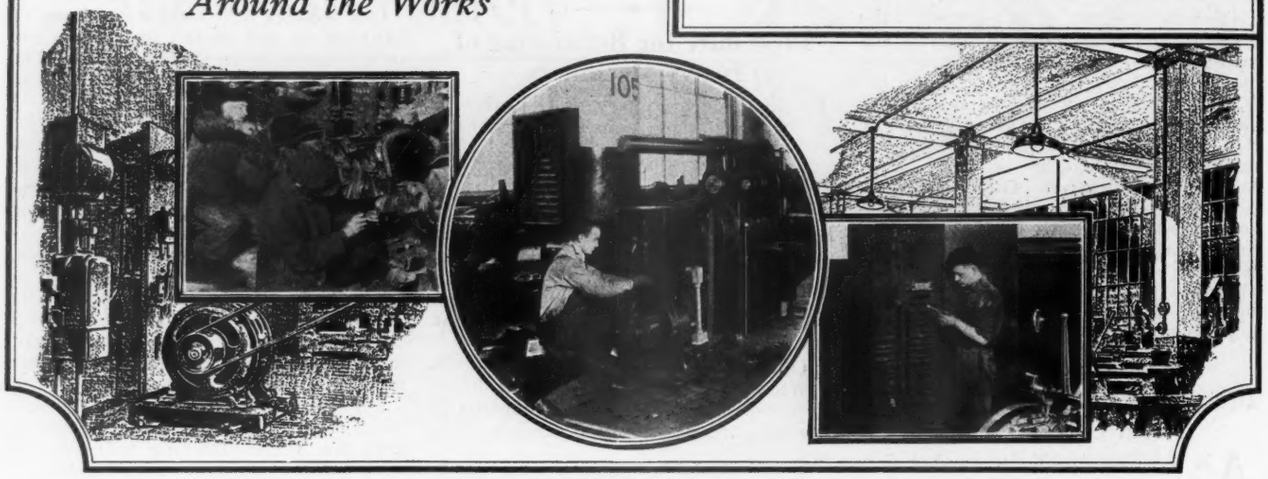
SKYLIGHTS and windows are provided to enable workers to take advantage of natural daylight but if the windows are neglected and grime and dirt allowed to cover the glass, much of its effectiveness is lost, especially if rough or translucent glass is used. Dirty windows can easily make it necessary to supply artificial illumination an hour or two extra each day and often all day, when it might not otherwise be necessary.

The big difficulty lies in getting a solution which will soften this grime without requiring too much labor and time or damaging the steel sash. After numerous experiments with various home-made cleaning compounds, some of which contained acid and destroyed the metal sash, while very few of them cleaned satisfactorily, the Economy Engineering Co., Chicago, tried out a liquid cleaner sold under the trade name of Glow-Brite, which not only cleaned the glass quickly and well but did not affect the metal sash. It is only necessary to rub this cleaner on the glass to dissolve the dirt and then flush it off with clean water. In this plant, part of the offices and the two-story assembly floor near the center of the building depend upon skylights for natural illumination. For this reason it is essential that the skylights be clean enough to really provide some light and the use of this cleaner has solved what was formerly a troublesome problem.

Electrical Service

Around the Works

For this section ideas and practical methods devised to meet particular operating conditions are invited from readers. The items may refer to inspection, overhauling, testing or special installations.



Novel Method of Finding Ground In Generator Armature

IN A PLANT where I was employed, a steam-pipe split one morning just before starting time. The break occurred above the outboard bearing of one of the 150-kw., d.c., engine-type generators and before the steam could be shut off at the boilers, the engine room was completely filled with steam and, of course, everything was well soaked.

As soon as the broken pipe had been replaced, all of the machines were started up and run slowly for several hours, in order to dry them out. The generator nearest the break apparently got the worst of it, as almost all of the paint was washed off. However, it was put on the line the following day and seemed to carry the load as well as usual, but after two days' run, it was noticed that there was a ground on that machine.

The usual tests were made, but the ground could not be located by our crew; so an expert electrician was called in. He decided that the machine would have to be dismantled and the armature rewound, estimating the probable cost to be between $300 and $400. The chief did not believe that rewinding was necessary; so with our own crew the trimmings were removed from the machine and at the chief's direction the armature was turned until a certain side was up. The top half of the field was pushed over with screw-jacks towards the fly-wheel and as the ceiling of the engine room was so low that there was no room to use chain-blocks, timber was used to block it up from the wheel-pit.

Three of the bands were removed from the armature and the commutator leads raised from the front end of one of the slots. The insulation was found to be burned through and the bare wire was in contact with the armature core. After reinsulating the wires with rubber tape and shellac and painting with asphaltum paint, they were replaced.

The bands were wound on by hand, as it was impossible to run the machine on account of the blocking through the flywheel, but the job was accomplished by soldering each turn as it was drawn tight. The field was then pushed back in place and bolted, and the brush-holder rigging reassembled. Upon starting up, the generator ran as well as ever and the whole cost of the repairs did not exceed $10. On being asked how he located the trouble so quickly, the chief replied that he smelled the burned insulation at that particular slot in the armature.

Utica, N. Y. M. M. BROWN.

Methods Employed for Locating Open Circuits

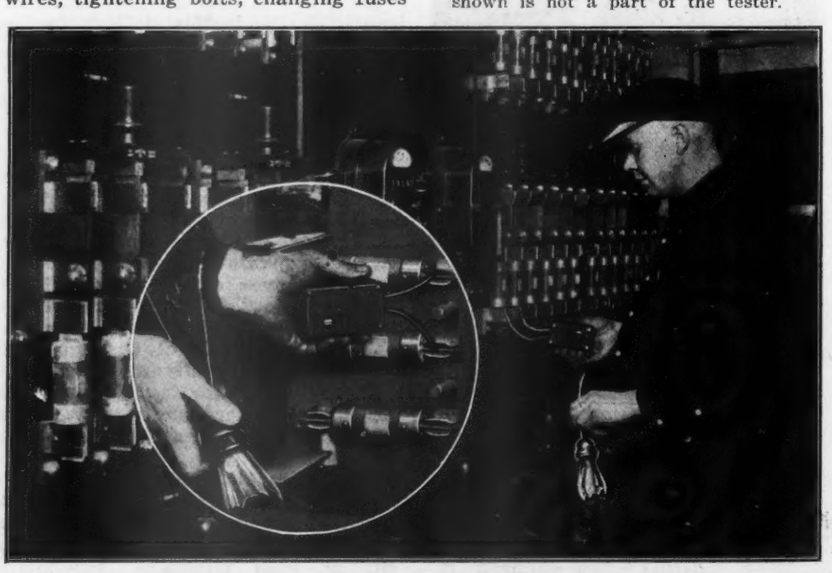
ONE of the most frequent causes of delay charged to the electrical department are open circuits due to disconnected wires, blown fuses, loose connections and the like. There are several ways of locating the open circuit causing the trouble. Probably the most common method is by guessing. The trouble man hurries around pulling wires, tightening bolts, changing fuses and the like, loses a lot of time and perhaps finds the trouble only by accident. A method often used to determine whether a fuse is blown is to remove it from its clips and shake it. If it rattles it is considered "blown" or "open."

A more reliable way of locating open or blown fuses is to use a magneto. However, in this case it is best to have the power off the line. This is not always convenient. Moreover, the magneto, since it is heavy and cumbersome, is not always at hand when the trouble occurs.

A common method involves the use of a test lamp. This is open to the objection that if several voltages are in use in the plant, it is necessary to carry several different lamps; otherwise, if a low-voltage lamp is used on a 440-volt circuit, it will blow up and may

Method of using tester for locating blown fuses.

The leads of the tester are placed across the fuse clips. If the fuses are intact a small lamp within the tester lights up. The broken lamp shown is not a part of the tester.



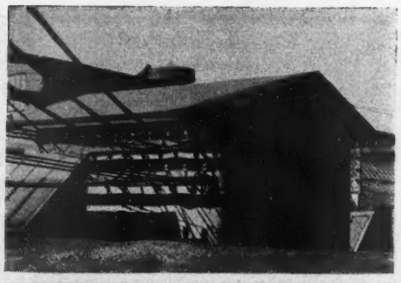
injure the person doing the testing. Also the lamp socket and lamp are often broken, thus adding extra expense and causing a delay until another lamp is obtained.

Another method is to use a fuse and circuit tester such as made by the Electric Tester Mfg. & Sales Corp., Portland, Ore., and shown in the accompanying illustration. This tester is small and easily carried in the inspector's pocket; hence, it is always at hand. It can be used on alternating or direct-current circuits from 110 to 600 volts. For voltages lower than 600 volts, a push button switch shorts out some of the resistance in series with the lamp. If the push button is accidentally pushed while the tester is on a 600-volt circuit no harm will be done. The lamp is enclosed in the tester and hence is not readily broken as is the case with the open lamp and lamp socket.

Portland, Ore. L. D. JOHNSON.

Distributing Outgoing Feeders From Wire Tower

IN ANY plant which has an extensive electrical system, conductors either in conduit or in open wiring, passing through walls and across the ceilings in the various departments often take up useful space. When many lines are run they have, of course, a more sightly appearance if they are arranged as neatly and compactly as possible, than when loose and much spread out.



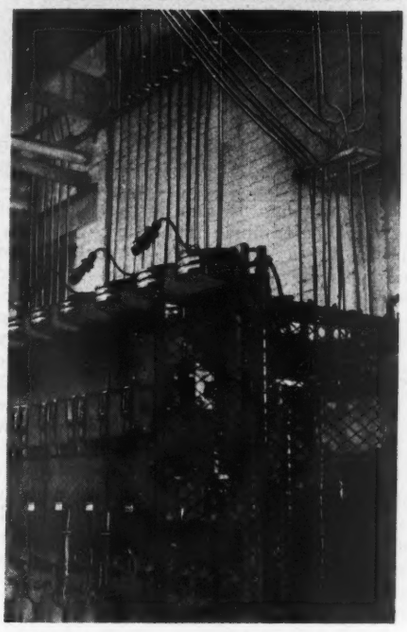


Fig. 1—Wire tower on roof of large industrial plant and, below, method of running feeders from switchboard to tower.

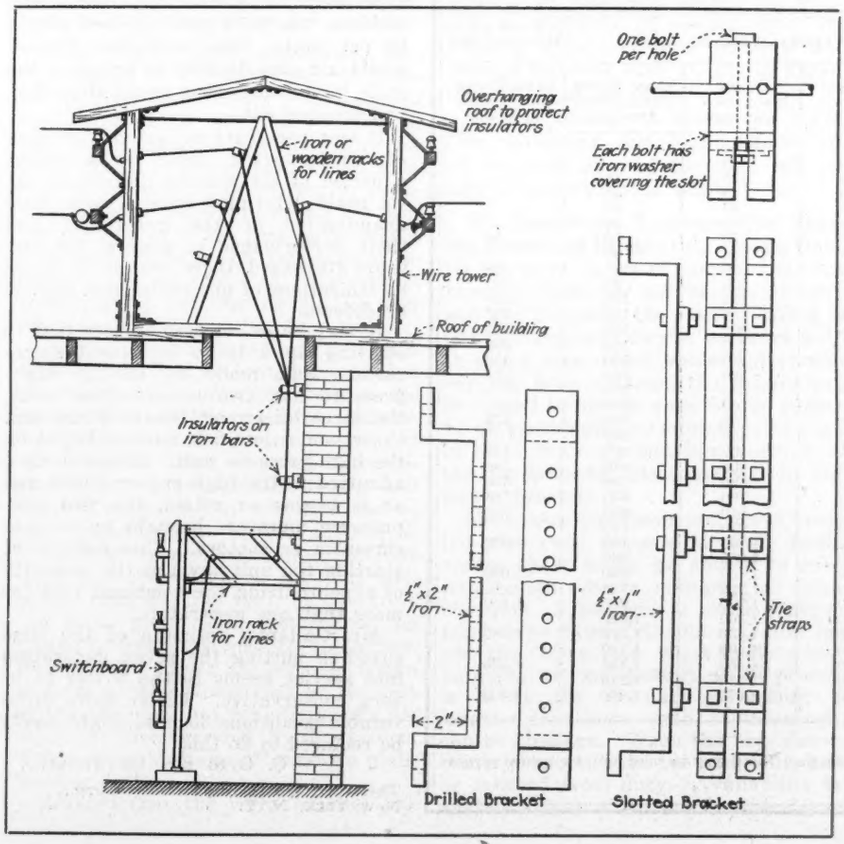


Fig. 2—Details of wire tower and at the right, drilled and slotted brackets for supporting porcelain cleats.

If large cables are run across the ceiling and through walls much space is needed for large cleats, strain insulators, brackets and so on; besides it is almost impossible to draw such conductors tight, and hard to keep them that way. Also inside wire must be rubber covered and if it is in conduit another expense is added, while if the conductors were run outside weather-proof wire could be used at less expense.

A wire tower erected directly over the switchboard, or nearly so, affords a neat and inexpensive method of getting feeders out of the way. Then the lines can be carried up the wall into the tower and from thence to the various buildings and departments by long spans over roofs or through alleys and over yards, being supported by strong arms bolted to the corners of buildings or on iron pipe racks on the roof. This scheme does away with carrying a multiplicity of conductors through walls and when the conductors leading upwards from the switchboard are uniformly spaced from 3 in. to 6 in. apart and drawn tightly, they are not an eyesore. Fig. 1 shows the general arrangement of the conductors leading from the switchboard to the tower, as well as a view of the wire tower. Details of the construction of the tower are given in Fig. 2.

White, slow-burning insulated wire can be used from the switchboard to the tower and there spliced to either weather-proof or rubber-covered wire which is used for the outside run.

The lines above the switchboard should be so arranged on 1-wire porcelain cleats bolted to iron brackets that they will all be properly spaced and yet quite compact, and should turn in at the top of the board to allow head-room for workers behind the board later on. Where many lines are carried up the wall, brackets can be used to accommodate one tier in front of another with at least 6 in. between.

If any lines are to be transposed or crossed to a certain point, the crossing should be done either behind the board or up in the wire tower, and not where it would be unsightly, as on the wall. Iron brackets on the wall look much neater than wooden ones, and should be painted black or white.

It is advisable to use a fair-sized cleat, such as No. 2 or No. 2½ for as many conductors as possible before changing to other sizes. The brackets on which the cleats are mounted may be either drilled or slotted. Details of both the slotted and the drilled type are given in Fig. 2.

Up in the tower the wire should be carried on an iron rack, provided with cross arms and cleats, which straddles the opening in the roof. Here the lines may be turned in almost any direction so that they will emerge at the proper arm and pins fastened to the outside of the tower. As they leave the tower from a supporting rack outside, the lines should be spaced at least 12 in. apart. The small conductors may be tied to pins; the large conductors should be fastened to the arms by strain insulators. The tower must, of course, be made strong enough to withstand any strain imposed by the lines.

New Britain, Conn. H. S. RICH.

Conductors With Varnished-Cambric Insulation Can Carry More Current

RECENT observations in the field indicate that varnished cambric insulated conductors are coming into wider and wider use in electrified industrial plants of the most progressive type. This is because, in part, varnished cambric is not damaged by heat as easily as is rubber. As a result, according to the code of the National Board of Fire Underwriters, varnished-cambric-insulated wires and cables may carry approximately 20 per cent more current than those insulated with rubber compound. This means, of course, a saving in copper. Usually the next smaller size of varnished-cambric-insulated wire may be used instead of a certain size of rubber-covered. However, the varnished cambric may be used in sizes smaller than No. 6 only by special permission of the Fire Underwriters.

The code of The Associated Factory Mutual Fire Insurance Company, an organization which operates extensively in the Eastern part of the country, allows the larger sizes of varnished-cambric-insulated conductors to carry upwards of 40 per cent more current than is allowed by the National Electrical Code for rubber-covered conductors of the same size. This is shown in the accompanying table, which gives the carrying capacity allowed by the National Electrical Code for conductors with rubber and other classes of insulation, and the corresponding carrying capacity allowed by the code of The Associated Factory Mutual Fire Insurance Company for varnished-cambric-insulated conductors.

There are also other advantages. Varnished cambric is not so easily damaged by corona as is rubber, so that where current is distributed in large plants at the primary voltage it is preferable, as corona may be present in sufficient amount to damage rubber even if it is not visible to the eye. Of course, varnished cambric is almost universally used in power houses for the high-voltage, alternating-current, single-conductor leads, when paper insulation is undesirable on account of the inductive effect of the lead sheath necessary to protect paper against moisture.

This brings up another advantage of varnished-cambric insulation, which is, that it is reasonably impervious to moisture. While conductors insulated with this material cannot, as a rule, withstand submersion in water for long periods, unless sheathed in lead, they are not injured by a considerable amount of moisture in the air. This immunity to harm from a reasonable degree of moisture means that extreme care and skill are not required in splicing. Therefore these cables are desirable for use under circumstances where expert splicers are not readily secured. Of course, for underground sections between buildings the cables should be covered with a lead sheath.

New Canaan, Conn. F. A. WESTBROOK.

Allowable Carrying Capacities of Wires With Different Classes of Insulation

B & S Gage	Diam. of Solid Wires in Mils.*	Area in Circ. Mils.	National Electric Code			Factory Mutual Code
			Rubber Insulation, Amperes	Other Insulation, Amperes	Varn. Cloth Insulation, Amperes	Varn. Cloth Insulation, Amperes
18	40.3	1,624	3	5	.....	.....
16	50.8	2,583	6	10	.....	.....
14	64.1	4,107	15	20	18	.....
12	80.8	6,530	20	25	25	.....
10	101.9	10,380	25	30	30	.....
8	128.5	16,510	35	50	40	.....
6	162.0	26,250	50	70	60	50
5	181.9	33,100	55	80	65	.....
4	204.3	41,740	70	90	85	80
3	229.4	52,630	80	100	95	100
2	257.6	66,370	90	125	110	120
1	289.3	83,690	100	150	120	150
0	325.0	105,500	125	200	150	175
00	364.8	133,100	150	225	180	200
000	409.6	167,800	175	275	210	250
.....	.....	200,000	200	300	240	275
0000	460.0	211,600	225	325	270	.....
.....	.....	250,000	250	350	300	.....
.....	.....	300,000	275	400	330	375
.....	.....	350,000	300	450	360	.....
.....	.....	400,000	325	500	390	450
.....	.....	500,000	400	600	480	550
.....	.....	600,000	450	680	540	630
.....	.....	700,000	500	760	600	720
.....	.....	800,000	550	840	660	780
.....	.....	900,000	600	920	720	.....
.....	.....	1,000,000	650	1,000	780	900
.....	.....	1,100,000	690	1,080	830	.....
.....	.....	1,200,000	730	1,150	880	1,030
.....	.....	1,300,000	770	1,220	920	.....
.....	.....	1,400,000	810	1,290	970	1,150
.....	.....	1,500,000	850	1,360	1,020	.....
.....	.....	1,600,000	890	1,430	1,070	1,250
.....	.....	1,700,000	930	1,490	1,120	.....
.....	.....	1,800,000	970	1,550	1,160	1,320
.....	.....	1,900,000	1,010	1,610	1,210	.....
.....	.....	2,000,000	1,050	1,670	1,260	1,400

*1 mil=0.001 in.

NOTE—Varnished cloth insulated wires smaller than No. 6 may be used only by special permission of the Fire Underwriters.

Quick Method of Synchronizing Generators After Excitation Failure

IN THE March issue of INDUSTRIAL ENGINEER, page 148, J. H. Gallant described under the above heading a method of synchronizing generators which is quite practicable and has been used by the writer on a number of occasions. In a power station where four 5000-kva. units were installed excitation was lost through the flashing-over of a single exciter unit which supplied the four units. The generators and exciter were all waterwheel driven. The restoration of service was handled as follows: (1) The low-tension oil circuit breakers on the low-voltage side of the step-up transformers were opened. (2) The resistance was then cut into the exciter field and the exciter breaker closed. (3) The generator field switches and rheostats as well as the main generator oil circuit breakers not having been touched, it was only necessary to bring the exciter voltage up to normal. (4) As the exciter voltage rose the generator ammeter showed when the machine pulled into synchronism and slight adjustments of the field rheostat reduced the cross currents to a minimum. (5) Almost simultaneously with the "pulling in" of the generators, the step-up transformer breakers were closed and service was restored.

So far as damage to the generators is concerned, the final answer to this question should be given by the designer of the unit, but so far as the writer was able to observe, no excessive currents were indicated on the main generator ammeter.

For the case considered in the writer's experience, the speed regulation of the turbines was very good, in fact within 10 per cent. This particular feature would aid considerably in bringing the units into synchronism again after they had dropped out.

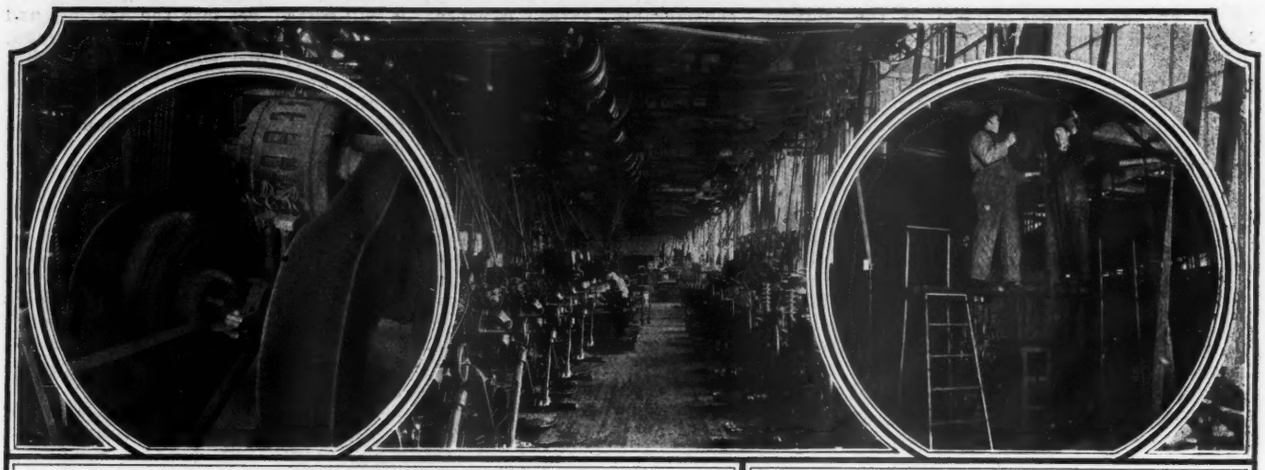
It was necessary to use this method of synchronizing three times within a period of six months and so far as we could determine from a superficial examination of the generators and their performance in general for two years afterward, there were to be found no indications of any permanent trouble or defects.

It may be of interest to note that in starting up a large compound steam turbine unit made up of one high-pressure and two low-pressure units, the three oil circuit breakers are first closed and a low field current is put on the high-pressure unit. Steam is then admitted to the high-pressure unit and as it begins to rotate, the two low-pressure units are brought up to synchronism as motors. This method of starting the unit obviates the necessity of synchronizing the combined unit for more than one generator.

Mr. Gallant's estimate of the time saved in putting the seven generators into service seems to the writer to be very conservative. Under more unfavorable conditions 30 min. might easily be required to do this.

C. OTTO VON DANNENBERG.

The J. G. White Engineering Corp., New York, N. Y.



Mechanical Maintenance of

Power Drives

This department will furnish mechanical details of installation, operation and maintenance of equipment in the path of power service from the first mechanical driving element through transmitting equipment to all driven machines.

Three Additional Comments of Manufacturers on Possible Improvements in Bearing Service

BEGINNING on page 264 of the June issue of INDUSTRIAL ENGINEER representatives of several bearing manufacturers told under the above heading, what has been done in the way of making improvements in bearing operation, with some of the practical points to consider when installing sleeve and anti-friction bearings in equipment. Here are three additional comments which came in too late to be included with the others.

John Taylor, SKF Industries, Inc., New York, N. Y.: As we see the bearing problem it naturally resolves itself into three parts: (1) The selection of the proper bearing type and size for the work to be done. (2) The installation of the bearing so selected in a correct manner, which will insure the user getting out of it its best performance and that measure of satisfaction to which he is entitled. (3) The correct treatment of the bearing by the user after the installation has been made.

In each of these headings is a situation which, it is evident, requires that the bearing manufacturer receive the co-operation of the machine builder, for selection of the bearing type and size must be based on a set of conditions which are submitted to the ball bearing engineer, but which he has no part in collecting. With his background of experience along similar lines and knowledge of previous successes (and failures too), he can from the facts given him determine the proper bearing type and size to employ. He will also adjust his housing design to form a harmonious part of the rest of the machine, but too frequently his work is circumscribed by limitations which are a heritage of previous plain bearing designs.

Granted that the right bearing has been selected and properly mounted, it still remains for the machine user to see that it has such attention as will insure its standing up to its work. This attention, although infrequent, is nevertheless essential. The very fact that lubrication periods are so far apart makes it easier to forget them altogether, and just as important as seeing that the bearing has an ample amount of lubricant within its housing, is the duty of seeing that the housing is kept clear of moisture and foreign material such as dirt or abrasive matter of all kinds.

If this trinity of essentials, Selection, Mounting and Maintenance, are all properly allowed for they will result in a harmonious whole.

Mr. Donaldson, Engineer, The Bunting Brass and Bronze Co., Toledo, Ohio. Of the many types of journal bearings brought forth by aid of the dividers and the T-square, the sleeve bearing is the patriarch and carries its years well. In every case where successful service has not been obtained the failure can be traced to one or more of the causes to be specifically mentioned later, and is in no way attributable to error in the fundamental idea involved in the sleeve bearing.

Mechanics who favor the sleeve bearing give clear reasons for their faith, among them being its ability to take punishment with a minimum of deterioration. Simplicity is another argument in its favor. Should necessity insist the sleeve may, when badly worn, be bored out and babbitt metal poured in to fit the journal, preventing a lengthy shut-down until replacements can be obtained. When the new sleeve bearings are at hand the makeshift can be relieved from duty. Availability is another strong argument for the sleeve bearing. In machine designing it is often necessary to have the rotating member enlarged on both sides of the portion allowed for the bearing, notably in case of a crank shaft. It is rather a difficult feat of engineering to use any other type of bearing, but the split sleeve bearing makes light of this difficulty.

The sleeve bearing properly designed and made, properly installed and properly lubricated, may be trusted to do its duty properly. On these points pivot its success or failure. If they are attained and maintained the bearing will last indefinitely. Whether the life of the sleeve bearing shall be long and smooth or short and turbulent, is determined by its progenitor—the mechanical engineer. His is the duty of accurately ascertaining the maximum load to be carried by the bearing. Included in his calculations is the amount of freedom to be allowed—the difference in diameter between the journal and the bore of the sleeve. The space he allots should provide room for a film of oil sufficiently heavy to sustain the load put on it by the journal without becoming crushed or broken. Should this happen the journal and sleeve will be in direct rubbing contact, friction increases, heat is generated and the viscosity of the new oil supplied to the bearing is destroyed. The result, if a remedy is not applied, will no doubt be stoppage of the machine and in extreme cases twisting off of the shaft.

There is little to be said about the making of a sleeve bearing that is not included in the duty of the designer. When the bearing is made of cast metal the designer determines its composition, he establishes the size of bore, number and position of oil holes and form of oil grooves. The oil holes he indicates on that side of the bearing opposite to the load-receiving side. He makes the oil grooves of generous proportions, but few in number. Close to each end of the bearing he puts annular grooves. The annular grooves prevent the flow

of oil on the journal outside of the bearing and have one or more holes drilled in the lower side to allow the used oil free return to the oil reservoir when oiler rings are used. The distributing or lateral grooves connect the oil holes with the annular grooves, and it is their mission to convey the oil along the bearing, allowing the journal to cover itself with a film of oil.

One style of conveyor groove that has given general satisfaction is curved in form, the curved groove cutting through the center of the oil holes and the ends pointing in the direction of travel of the journal, allowing the oil, as we may say, to run down hill. In the case of a rapidly revolving journal this design of groove may become an oil pump and flood the bearing, in which event the curve is reversed. In no instance should the conveyor grooves extend below the center of the bearing,because any grooves on the load side of the sleeve would tend to disrupt the oil film and also lessen the pressure area of the load surface.

Installing a sleeve bearing should not be intrusted to the millwright's apprentice. To obtain desired results the shaft must be straight and the bearings in perfect alignment; otherwise the load intended for the full area of the bearing will be thrust on only a small portion of that area.

The proper lubrication of the bearing is the final consideration and, like woman's work, it is never finished—it must be continually repeated. Drop cups or oiling rings are considered two of the best methods of insuring a constant supply of lubricant. The capillary attraction of wool as an oil-delivering agency is well thought of by some lubrication experts. But no matter by what method the oil reaches the bearing, the vital point is to get it there—plenty, but not too much.

R. Pruger, Power Engineering Department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.: Wherever machinery is found, bearings and shafts are essentials; and wherever machinery is used, human intelligence must be applied to keep things running smoothly. There are cases where bearing troubles form a large percentage of the yearly repair bills, and others where this item is rather a small fraction, and sometimes the smallest fraction, of the total upkeep expense. Why?

Since such conditions exist, there must be an answer. The motor user is probably the one most interested in finding the right answer to this question, since there are places which not only make it difficult to get at the motor for repairs, but where a continuance of production is vital. Yet, it is surprising to note the large number of bearing failures and the large number of motor users who accept such failures as a matter of course. There is no more reason why motor bearings should give trouble due to oil leakage than why other defects should be tolerated.

To accomplish this, it is first of all necessary to find out the reason why failure occurs. To change over to some other type of a not-yet-established reputation is hardly good policy, particularly where such a change may involve considerable extra expense.

I feel sure that ninety-nine out of a hundred engineers and operators have not seriously made a study of their troubles; they hear of something else, and at once jump to the conclusion that they must change over in order to remedy their troubles.

First, there is the matter of oil leakage. This is serious for not only does it mean the waste of a large amount of lubricant, but, what is worse, it means that the escaping lubricant enters the motor, destroys the windings, short circuits the commutator, and creates various troubles. In spite of this, there are many plants where the oiler is instructed to see to it that the housings are kept well filled and accordingly, oil is poured into the bearings once or oftener every day. Of course the oil level must be maintained—no doubt about that—but why not issue instructions to make a report of such cases, and then find out just why a certain bearing needs replenishing of lubricant so frequently?

It has been noticed not infrequently that oilers pay little attention to the proper oil level; the oil can is used freely, and while the stream is flowing, attention is not always concentrated where it should be—that is, on the overflow plug. In one case it was noticed that the overflow gage, a drilled hole on the side of the housing, was completely stopped up with dirt and sawdust; and bearing was given a generous supply of oil until it ran into the motor through the clearance in the housing bore on the inside end. A toothpick applied to these overflow gage holes had the effect of creating considerable overflow, getting the oil level back to where it belonged. In another instance oil-hole covers, supposed to be firmly held down by screws, had been loosened to permit of oiling through the oil-ring slot in the top of the housing instead of making use of the proper filling hole which was a little slower, of course. Air was thus admitted freely to the bearing and the suction on the inside end of the housing set up by the blower drew air currents through the housing, carrying oil vapor and streams of oil.

Bear in mind that one of the principal troubles of oil leakage is the fact that the bearing is not held air tight; if the air gets in, the oil will get out. The "outlet" itself, which is the opening around the shaft (usually 1/16 in.) is not harmful, if the inlet is closed; and that means the oil-ring slot, peep hole, and other such openings.

The bearing should have annular grooves at the motor end, or better still, at each end, and one or two holes at the bottom of the groove; this will get rid of the oil after it has done its work in the bearing, and relieve the oil thrower. Also, look to the oil thrower, and where it throws the oil, and where the oil so thrown off will flow. If it is allowed to get back on the shaft beyond the thrower, and thus escape, this defect can be easily overcome by a little ingenuity. Keep your bearings clean; change the oil shortly after a new motor has been put into operation. Core sand may have been missed by the air blast, in which event it will soften, get into the bearing, and wear it out. Dust-proof the bearings; if you don't, dirt will get in, and that means wear. It is not to be wondered at that bearings fail in such places as foundries, where the air is cloudy with fine sand floating around.

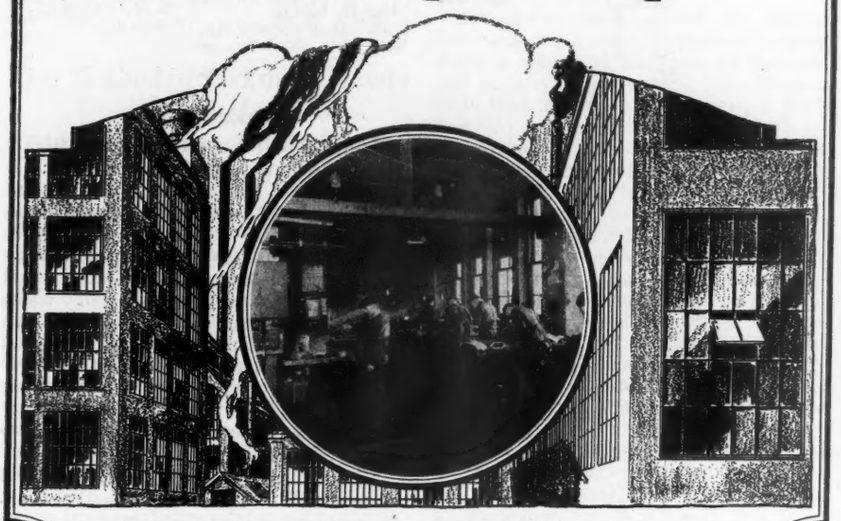
Don't put your gear or pulley away from the housing, when it might just as well be close to it, because the shaft deflection will concentrate pressure on one end of the bearing, and cause "galling" That seems plain, and yet I recall a case where this very thing happened; the motor being used to run a tight and loose pulley of some machine, the tight pulley drive was arranged so as to be farthest from the motor bearing; result, trouble every few weeks. Now, there is another case, which may be doubted, but which is a fact: In one plant, it was found necessary to rebabbitt the bearings, and in this case the repair shop was located some distance from the motor. The repair man, in order not to have the babbitt cool, superheated the metal, carried it in the ladle to the motor and poured the babbitt around the shaft and, to make matters still worse, this treatment was accorded a lead-base babbitt.

Rebabbitting, if it must be done, should be done correctly: no trouble to find out how to do it, but lots of trouble if you don't If you can not take the time to stop the motor long enough to take out the bearing for rebabbitting, get a spare one. Babbitt metal, particularly lead-base babbitt, must be handled very carefully at certain temperatures. You should make allowance for boring out, and then remember to provide for proper running clearance, and see to it that the oil grooves are cut, and cut correctly; they should connect up with the oil-ring slot and curve downward, since the flow of oil is in that direction. A groove along the line of pressure for horizontal belt pull is not the best form, since it allows the oil to escape when it should hold the pressure and form a film. Provide amply for a "relieve" to permit the oil to get under the shaft in a wedge shape; this will reduce bearing temperature, since it means a perfect film, carrying away the heat. Where the load is mostly downward, such a relief can be made for an angle of 20 deg. from the horizontal center line, merging gradually into the bore proper.

All these points are simple ones, obvious, and if followed will have good results. There are motors running with such bearings in dirty and dusty places, with no attention for months. As a matter of fact, I know of some cases where oil was put in when starting up, and no further attention was given or required, and that was a year ago.

So don't be hasty in forming an opinion of a thing which did not give satisfaction at once, until you know the reason why! And after you have found out, then figure out why you cannot overcome it if the other fellow can, and what it would cost you trying something new, of which you know no more than what some enthusiast has told you. The man who says "it can't be done" of a thing which "has been done," has never really tried to do it.

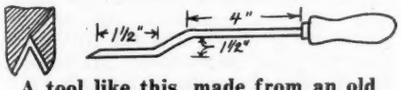
In the Repair Shop



This section is devoted to repair work, large and small. Special attention is given to shop or bench tools and short cuts or improved methods. Contributions are always welcome.

Easily-Made Tool for Trimming Slot Insulation

FOR TRIMMING the insulation in armature and stator slots we use a simple, easily-made tool which has given very satisfactory results. As will be seen from the accompanying illustration, the tool was made from an old, thin file. The temper was drawn and



A tool like this, made from an old file, will save time in cutting slot insulation.

the file then ground down until it was about ½ in. wide and ⅛ in. thick, after which it was bent to the form shown. The end was then filed to a V-shape and beveled to give a sharp cutting edge.

In use, the insulation in the slot is trimmed off flush with the iron by pushing the sharp edge of the V-shaped end along the top of the slot, with the paper between the sides of the V. The paper is cut smoothly and easily and we find that the use of this tool has reduced considerably the time required to do the job by other methods.

Peoria, Ill. GEORGE RINGNESS.

How to Make Motor-Driven Saw for Bench Use

FOR cutting thin steel or brass sheets, fibre or insulating materials and so on, a large shop has made up and uses a number of simple jig saws, the details of which are given in the illustration.

The blade holder is a forged steel part with hanger and tightener for keeping the blade taut. A 12-in. blade can be used to advantage, as this is a standard length.

The back of the holder is provided with a T-edge as a guide and terminates at the lower end in a link connection for the rod which connects it to the driving pulley. A slotted bracket for supporting the saw vertically above the bench has a T-slot in which the blade holder moves and thus serves as a guide. According to the facilities available, brackets may be made of cast iron, forged steel or brass.

A simple strap bracket mounted under the bench supports on a suitable bearing a small pulley fitted with an eccentric pivot. A short link or rod on the pivot connects the driving pulley to the link at the bottom of the blade holder. The saw is driven by a ¼- or ½-hp. motor which is also mounted underneath the bench and belted to the saw pulley by a flat belt.

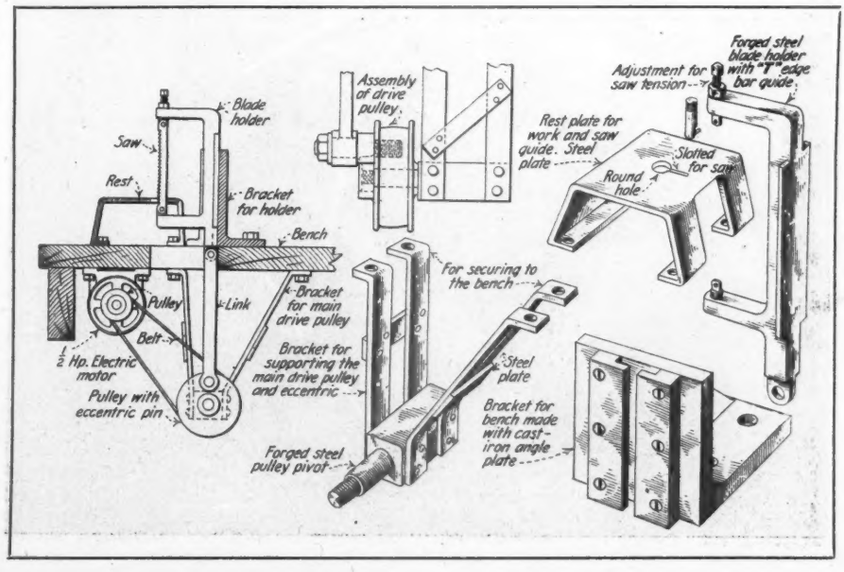
The rest plate for the work is made from sheet steel or boiler plate which is bent to shape and the saw opening made as shown. A drilled hole clears the chips, while the narrow slot guides the blade. Dimensions are not given in the illustration as they are not of particular importance and may be varied to suit the conditions or materials available.

In operation, the saw blade travels up and down at a high rate of speed; the work is supported on the rest plate and brought in contact with the saw which slots or cuts it easily and accurately. When cutting out intricate designs, the sheets are marked in outline from a master part and can be cut out almost as rapidly as they can be fed against the blade.

When a shop has much work of this character, this power-driven saw will be found to be a very useful tool as it will save a great deal of time and labor, enabling the workman to do a neat and accurate job in much less time than would be possible by the use of other methods.

Washington, D. C. G. A. LUERS.

Details of construction of motor-driven jig saw which can be mounted on the work-bench.



High-Voltage Test Set for Use in the Repair Shop

ARMATURES, after they have been rewound, should be subjected to a high-voltage test from the copper to ground. The voltage used should be twice the rated voltage of the apparatus plus 1,000. Also, it is sometimes necessary to apply high voltage to a grounded armature so as to locate the ground and patch it. The same tests are made on field coils, transformers, auto-starters, and in fact to almost all electrical apparatus that goes through the electrical repair shop of an industrial plant.

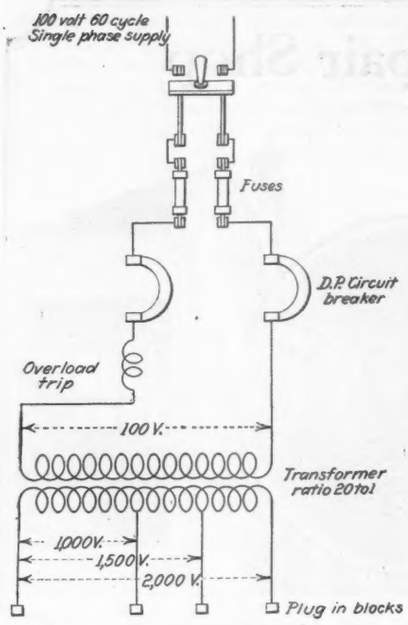
A test set that is capable of doing this work and has the advantage of being portable is shown in the accompanying illustration. This set can easily be made from materials that are at hand in most electrical repair shops. A cart for carrying the set was made by mounting wheels and a handle on a platform, as shown in the illustration. The transformer was placed on the platform and on the panel attached to the transformer were mounted a circuit

breaker, knife switch, fuses and a plug-in block for the high-tension leads.

The transformer is an ordinary 5-kva, distribution, pole-type transformer, rated at 2,200 volts on the high-tension side and 110 volts on the low-tension side. The transformer is laid on its side and bolted to the platform of the carriage. Since the transformer receives only intermittent service, it is unnecessary to use transformer oil in it. A wooden or asbestos-board panel is bolted to the top of the transformer and the circuit breaker, knife switches and fuses bolted thereon, as shown in the illustration.

The low-tension side of the transformer is connected, as shown in the diagram, through a double-pole circuit breaker, fuses and knife switches. It is connected to a 100-volt, single-phase, 60-cycle supply. A 110-volt, 60-cycle supply would do just as well, although the high-tension voltages would then be 550 volts, 1,100 volts, 1,650 volts and 2,200 volts. The circuit breaker should be set to trip at 20 amp. and 35-amp. fuses should be used.

Special taps have been made to the high-tension winding, as is shown in the diagram of connections. A tap is made in the middle of the high-tension winding and at three-quarters way through the winding so as to give approximately 1,000 volts and 1,500 volts respectively. These taps are brought to the plug-in block, shown in the illustration, mounted above the transformer. The high-tension leads can be plugged into this block to obtain 500 volts, 1,000 volts, 1,500 volts or 2,000 volts. Five hundred volts are obtained by plugging into the two middle receptacles. The remaining voltages are obtained by plugging as indicated in the accompanying diagram.

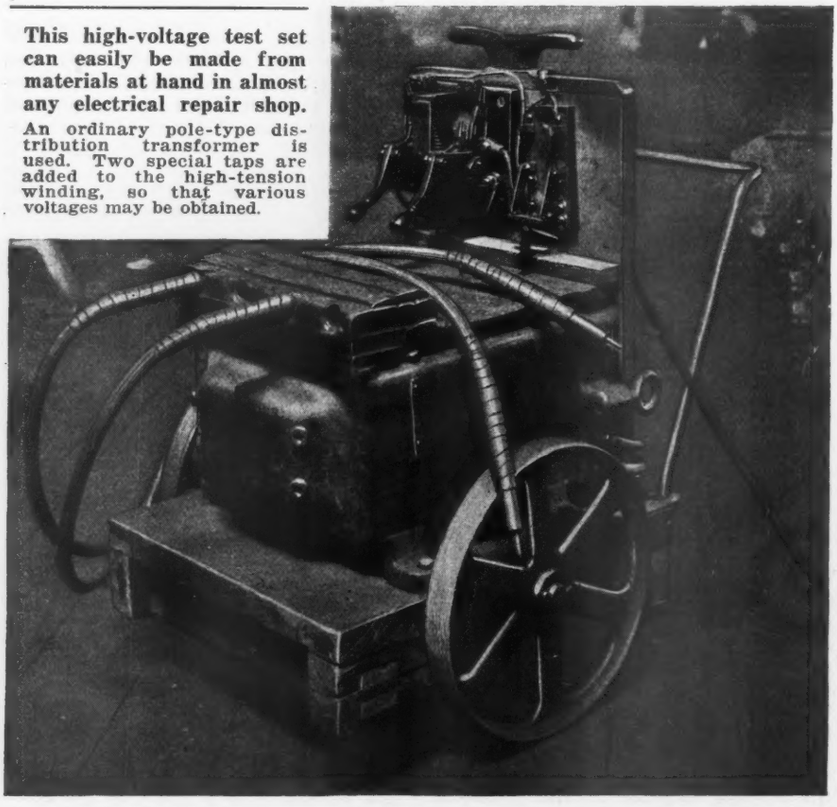


Four values of high voltage for testing can be obtained from this high-voltage set.

Five hundred volts are obtained from the two middle blocks. The other three voltages are indicated in the diagram.

The high-tension leads are made of No. 6 or No. 8 extra-flexible, rubber-covered wire. The leads should be about 10 ft. long and are placed in a good grade of rubber hose to protect the wire and to give the increased insulation required for the high voltage. The ends of the hose are taped so as to make a neat appearing job. A hook-shaped or spike terminal may be used on the testing end of the leads. The connection end should have a plug terminal to fit the receptacle in the plug-in block.

E. M. FEHRLIN.
Diehl Manufacturing Company,
Elizabeth, N. J.



This high-voltage test set can easily be made from materials at hand in almost any electrical repair shop.

An ordinary pole-type distribution transformer is used. Two special taps are added to the high-tension winding, so that various voltages may be obtained.

Broken-Down Insulation Cause of Trouble With Rotor

RECENTLY we found out what was the matter with a 15-hp., 440-volt, three-phase, fifty-cycle, squirrel-cage motor which drives a foundry sand mixer having a capacity of eight wheelbarrowfuls. This motor had been in operation about two years and had always given trouble. When the mixer was set up it was given a try-out at full load and as the sand was a trifle damp it was noticed that the motor hesitated about getting up to speed.

Later on, dry sand was used and the motor still slowed down perceptibly. In fact, when the sand was shot out of the chute on to the mixing blade the motor would almost stop. The trouble was slightly relieved by using less sand, but for many months this condition was tolerated without knowledge of the real cause; the wattmeter even failed to show any continued overload. During the past few weeks the motor slowed down more than ever. When the load came on it would practically stop for about five seconds and then slowly speed up to normal.

The mixer was looked over for tight bearings, the starter contact fingers were examined, the motor was thoroughly cleaned and its bearings tested, new oil was supplied, the winding tested for grounds, and the line examined for poor connections, but no cause for the trouble could be located.

The winding did not at any time heat up above normal and the only apparent trouble seemed to be that the horsepower was getting less and less, until the motor could carry little or no load at normal speed. The motor was finally taken apart, the winding examined for defects and tested for grounds, all the coils were closely scrutinized for short-circuits, poor insulation, loose connections, and so on, but no defect was found.

As this was not a wound rotor it did not seem to have any bearing on the problem, but after going over the other parts of the motor very carefully the rotor was rolled over and closely examined. It was then seen that about twelve slots showed slightly burned edges. The insulation covering these rotor bars was carefully picked away with a fine-pointed tool and many holes were found side by side in the twelve slots. The spots were not caused by the rotor striking the stator as the bearings were perfect. Also, as the motor was covered by a metal hood, it was not possible for a pebble or other small object to have got into it.

These defective slots were blamed for the slowing down of the rotor, and another motor was installed. The defective rotor was returned to the manufacturer and a new one procured; from that time on no trouble was ex-

perienced, the speed and power being satisfactory. Thus the whole trouble was caused by the broken-down insulation in twelve slots of the rotor.

New Britain, Conn. H. S. RICH.

Easy Method of Making a Handy Lead-Faced Hammer

THE article by G. A. Luers, describing a detachable brass head for a machinists' hammer, on page 207 of the April issue of INDUSTRIAL ENGINEER reminds me of a very handy hammer that I have in my set of tools. It is made from a tee pipe fitting and a piece of ½-in. pipe for a handle. The interior of the fitting is filled with lead and cast iron.

It is a very simple matter to make a mold for pouring the lead into the fitting so that the faces will project sufficiently far to prevent the cast iron from striking against the delicate part that is being struck.

To conserve lead I filled most of the space inside of the fitting with pieces of cast iron, the lead being poured around them.

A hammer of this kind is very useful for pounding delicate metal parts that would be battered by a steel, iron, or even a copper face.

As soon as the faces wear away simply throw the entire hammer into the melting pot, melt the lead out and repour.

Newark, N. J. N. G. NEAR.

Improper Soldering of Commutator Leads Causes Trouble

THOSE who rewind or repair armatures know that more trouble develops in the commutator than in the coils. Of the three troubles commonly found in armatures—grounded bars, bad mica and poor connections—I feel safe in saying that more damage is done by poor connections than by the other troubles. Many times the failure of the winder or repair man to take a little more time to do his work thoroughly when rewinding or repairing an armature, is the reason why it stays in service for only a short period of time, compared to what it would have done had he soldered the leads in the commutator more thoroughly.

It will often be noticed that there are several black bars on a commutator. In many cases, particularly where the machine is lightly loaded, this does not cause any trouble except possibly a slight sparking. Often, however, this condition gradually grows worse even if the commutator is turned down frequently, which should not be done as it does not remedy the trouble and causes a heavy loss of copper from the commutator.

When a motor or generator is running under a fairly heavy load it will not function properly unless there is good commutation. By "good commutation" I mean in this case, reversal of current with as little opposing resistance as possible. An improper connection, where the leads are soldered into the commutator bars, makes extra and unnecessary resistance. Current will not pass through a poor connection as well as it will through a solid one and when it is forced causes heating.

Armatures usually look as though the leads are perfectly soldered because there is solder on the front of the riser and an abundance on the top. Bear in mind that it is usually the bottom leads that are neglected. Therefore the good appearance of the top and front mean nothing. It is possible that there is only about 1/16 or ⅛ in. of solder back in the slots because the shoulder has been turned off smooth after soldering. When the bottom leads have not been sweated in trouble often arises because the copper tarnishes in the slot and offers a high resistance to the passage of current. With high resistance, heat is generated and many times a very hot commutator or an excessively warm armature may be caused by poor connections. It is only when the connections become very bad that serious trouble results. As a general rule, there will be a blackened bar or two where the trouble is and if it is not attended to when the commutator commences to spark badly, the solder may be melted out and a partial or perhaps a complete open circuit will result.

The black spots on the commutator will occur either on the third or on the half, or in just one place, depending on the way the armature is connected. On an armature of a bi-polar machine, there will likely be only one black spot as these armatures are connected 1 and 2. On a four-pole machine there will be two spots diametrically opposite, although there will be trouble at only one of them. On a six-pole machine there will be three spots on the third. This is in case there is only one bad connection showing up. When more than one is in evidence, the number of spots is increased in direct proportion to the number for one bad connection.

The reason that only one of each two or three black spots is the seat of the trouble is due to the fact that if the armature coils are connected for a four-pole machine the current must pass through two coils before returning to the bar next to the start. Therefore, there are two simultaneous reversals under opposite brushes causing two black spots; one where the trouble is and the other diametrically opposite to it. In the six-pole machine the coils are connected on the third and therefore the current passes through three coils before returning to the bar next to the start, causing three reversals simultaneously and also three black spots for each poor connection.

Recently I worked on a large generator that had twelve black spots on the commutator. As it was a six-pole machine, I picked out the four worst spots and lifted the leads. After cleaning and tinning the leads they were laid again and well soldered. This cleared the trouble.

Often the insulating varnish with which the armatures are impregnated after winding, will soak up in the back of the commutator and into the slots, if the leads are not soldered well. This is a very bad condition and soon develops trouble.

When clearing trouble due to poor commutator connections, do not just solder over the leads. Take them out of the bar and clean them well, also cleaning the slot in the bar with a hacksaw blade. Tin the leads before relaying them. This insures that the solder will flow to the bottom of the slot. If the commutator is very rough the best policy is to turn it off, although in many instances a sandstone or piece of emery stone will grind it smooth. It will be noticed that the mica between the blackened bars is a little higher than the copper. This leads many repairmen to believe that these particular mica sections are harder than the rest. They advise under cutting the mica. It must be said that this will relieve the sparking temporarily or at least lessen it, but the real trouble still remains. Where the commutator is blackened all around it shows that the brushes are not in the neutral plane, the machine is overloaded or the mica is too hard to wear down with the copper. In the case of hard mica, the only way to relieve sparking is to undercut the mica or else continually grind it smooth with a sandstone. Harder carbon brushes might also help, but undercutting the mica will often be very beneficial.

When a machine is overloaded, it is to be expected that some trouble will develop at times. An armature is more likely to develop trouble from poor connections when it is overloaded or loaded to capacity. Good soldering means satisfactory service and inasmuch as an armature winder usually does not know under what conditions the armature he is winding will work, he should make sure that he does a 100 per cent job of soldering.

Darby, Pa. GEORGE WM. HANLON.

Two Quick Methods of Stripping Closed Slot Armatures

THE question sometimes arises as to the best and quickest method of stripping a closed-slot armature. I have found that the best way of doing this is to burn off the old insulation in the slots and on the coil ends by applying a gasoline torch. If a torch is not available, wrap an old rag around the armature and saturate the rag and the winding with kerosene. Then take the armature out to an open space in the yard and set fire to it. Keep the flames away from the commutator as much as possible and strip the armature while it is still warm. The fire will not harm the laminations.

Another method which gives good results is to soak the winding in a hot solution of lye or Oakite. For this purpose, put a lathe dog on the commutator end of the shaft and either dip the armature until the winding is submerged, or hang the armature over the tank and pour the solution over the winding. Keep the commutator clear of the solution except where it is necessary to remica the commutator, in which case the whole armature can be submerged. After stripping bake the armature to drive out all moisture between the laminations, before rewinding.

Detroit, Mich. A. C. ROE.

Budgeting Maintenance Expenses

(Continued from page 316)

any over-runs must be justified by an explanation. The reasons for weaknesses and leaks are thus pointed out and rectified.

Sometimes it is found necessary to change the budget and to take care of this we have in use a form known as a "Request for Budget Change" (Fig. 3) which calls for an explanation as to why a change is necessary and has to have the approval of the general manager before it is taken into the records.

Of course, if there is a radical change in the sales or orders received as compared with our estimates an entire budget revision is necessary; in fact the budgets are gone over monthly with such revisions in view if necessary.

As an additional curb on the maintenance expenses, and so that we will have a complete accounting record of such work accomplished and the means for a correct allocation of charges, it is necessary for the foreman of any department to secure a Work Order, shown in Fig. 7 before any work is undertaken by the maintenance engineer. Full explanation of what is wanted and the reason why the work is required has to be detailed on this order and the approval of the superintendent or factory manager secured before the work is started except, of course, in the case of a breakdown job when, naturally, the work is at least started without waiting for the paper work to be completed.

On the reverse side of the accounting department copy of the Work Order are posted the details of the materials used, taken from the stores requisitions covering the withdrawal of the items from stores and the labor charged to the work, posted from the maintenance employees' time tickets.

These work orders cover both maintenance and plant additions; a monthly closing is made of any of the latter which are completed and the totals transferred from Uncompleted Plant Account to Completed Plant Account and allocated to the department involved. In the case of the maintenance orders the charges to all of these are closed out monthly and chargd to the particular maintenance expense account of the department for which the work has been done.

As the result of two years' experience with a budget system for maintenance and repair work, as we handle it, the following advantages are apparent: (1) Maintenance and repair costs can be closely estimated and controlled. (2) An accurate record is provided of the quantity and quality of the work of the maintenance department. (3) The foremen of the various departments have been led, by their desire to make a good showing in their department, to take a deep interest in maintenance work and thus assist the maintenance department in many ways. An incidental result has been the cutting down of power, heat, light and other like expenses through prevention of waste. (4) Performance of unnecessary maintenance or repair work is avoided. (5) A definite relation is maintained between production and maintenance expense. (6) Although the budgets are made up a year in advance, provision is made for increasing or reducing the estimated figures as conditions indicate.

Coil Insulation Troubles

(Continued from page 337)

The disadvantage is that when applied to coils operating on higher voltages where heat is developed in service the partial vacuum inside the windings prevents the transfer of this heat to the outer surface of the coils.

Treatment of Cotton-Covered Enameled Wire.—In this relation it must be remembered that we are dealing only with plain enameled wire coils. While the same practice is entirely suited to the treatment of cotton-covered enameled wire the precautions need not be so carefully followed out. The cotton serves as a space factor and prevents the conductors from actually coming in contact and short circuiting. The only danger is that the cotton may be pushed to one side, thus leaving the enamel on adjacent turns exposed to the action of the varnish solvent. Again, the fibrous insulation provides a greater surface for the entrance of heat and air, thus giving a chance for thorough and rapid drying of the varnish. Even those varnishes which are not advised for enameled wire work have been found to be quite successful for this kind of application because their solvents, although slower drying and having higher solvent powers, will remain in contact with the wire for an even shorter period than would be experienced in the case of the closely wound coils in which the plain, uncovered enameled wire is used.

You will observe that throughout this article the writer has emphasized the methods of treatment and the process of baking as the cure for all difficulties that may occur when there is no doubt that the proper type of insulation has been used.

Don't jump at conclusions. When trouble arises in connection with the insulation of a coil do not blame the wire, the tape, or the varnish employed in its construction. Follow the practice of a good cook. When a cake is spoiled she does not lay the blame on the brand of flour, eggs, baking powder, or other ingredients. She is not necessarily a brilliant person, but common sense has directed her to use only those products which she knows are right because they have been tested by time and experience. Hence, she examines first her methods of combining the various ingredients and observes wherein she has departed from that practice which previous knowledge tells her will always produce good results. If her methods are right, the oven next comes under her observation and she checks up on the temperature to make sure that the baking was carried out under proper conditions. Only as the last resort, when continued trouble under ideal circumstances is experienced, does she change the source of raw materials supply.

Just so with insulating varnishes. Select those materials which have stood the test of time and service. Keep a careful record of the oven conditions and your method of application. Then, should trouble occur, check up on all these details and observe the departures that have been made from those methods which previous good results show you are the correct ones to use.

If in spite of all precautions trouble still continues, consult your source of varnish supply. Having specialized in the problems of electrical insulation he should be in a position to render valuable aid.

The next, and final, article of this series will appear in an early issue of INDUSTRIAL ENGINEER. It will take up in detail the points to be considered in the selection of the proper insulating varnish for use, in view of the conditions under which the machine is to be operated.

Trade Literature
You Should Know About

Copies of literature which is described on this page can be obtained by writing to the manufacturer whose name and address are mentioned. It is always advisable to state the name and number of bulletin or catalog desired, as given in these columns.

Lewis-Shepard Company, 588 East First Street, Boston 27, Mass.—A booklet entitled, "These Twenty-four Business Concerns Increased Profits $59,565.88 Yearly," gives a list of concerns which have made savings by the use of Lewis-Shepard industrial lift trucks. For each concern the tabulation gives the cost of the equipment and the saving which is made during a year.

Electrical Machinery Manufacturing Company, Minneapolis, Minn.—Bulletin 833 shows the construction of the E-M Junior synchronous motors from 20 to 100 hp. for direct connection to small compressors. This bulletin also shows the advantages of the synchronous motor and in addition gives several pages of discussion to its operation. Bulletin 785 is entitled "Some Users of E-M Synchronous Motors and Vertical Alternators." A special chart indicates some of the possibilities of applying synchronous motors to equipment in different industries.

Acme Electric Heating Company, Department I, 1217 Washington Street, Boston, Mass.—A 32-page loose-leaf catalog illustrates and describes the various types of Acme electric heating devices for domestic and industrial use. These include disc and plate heaters, immersion and circulation liquid heaters (about sixty forms of immersion coils are illustrated by sketches), tube immersion heaters, electric steam boilers, various kinds of electric pots and ladles for melting sealing wax, metal, glue, pitch and other substances, embossing press heaters, tool heaters, as well as laboratory, laundry and kitchen electric heating equipment. Several pages are also devoted to electric radiators, foot warmers and to space and cartridge heaters.

Howell Electric Motor Company, Howell, Mich.—A new 16-page booklet entitled, "Give Red Bands Your Hard Jobs," describes and illustrates the construction of the various types of Red Band induction motors. Some of the topics discussed are: Frame construction, windings and stator insulation, the indestructible rotor, shafts, bearings, endplates, slide rails, starting equipment, starting torque and anti-friction bearings. Considerable space is given to a description of the method of winding the coils in slots so as to give heavy and durable slot insulation. This is also accompanied by a report of the Electrical Testing Laboratories which shows the high puncture rating of the double-cotton enameled wire used in this winding compared with other types of wires. Slip-ring motors, vertical motors and other special types of motors are also illustrated and described.

Stop Wall Plugs Company, 53 Park Place, New York, N. Y.—A folder describes the "Stop Plug" which is a hollow tube of stiffened fibre used for holding screws and hooks securely to any wall. A hole is first drilled into the wall which may be of stone, cement, tile or other material, the stop plug is inserted and as the screw is inserted into the hollow stop plug it expands the fibre to a tight fit in the opening. Screws may be removed and reinserted.

Federal Steel Products Company, Inc., 2-14 Avenue L, Newark, N. J.—Catalog 2 covers the various sizes and prices of Federal safety switches and enclosing steel cabinets for electrical devices.

Structural Slate Company, Pen Argyl, Pa.—A 90-page book entitled: "Slate for Electrical Uses," revised edition, contains the researches concerning natural slate made by it and also tests performed under the direction of the Structural Service Bureau of Philadelphia, Pa. Among the subjects discussed are: The development of electrical slate, uses, testing for electrical uses, specifications (electrical and physical), recommended mounting practice (with sketches), applications (illustrated), and several pages of information and engineering data.

Roller-Smith Company, 233 Broadway, New York, N. Y.—Bulletin 160 covers the Type GSA alternating-current, portable ammeters, voltmeters, volt-ammeters, single and polyphase wattmeters, frequency meters, power factor meters, transformers, multipliers, Y boxes and other instruments.

American Fixture Company, 230-232 West Water Street, Milwaukee, Wis.—Supplement catalog 4, shows the condulet adjustable electric light fixtures by which adjustable arms are fastened to ½-in. or ¾-in. condulet and so do away with exposed wires.

Union Electric Manufacturing Company, Milwaukee, Wis.—Publication 500 gives the "General Specifications of Design" on general purpose, drum-type starters and speed regulators, reversing and non-reversing, with accessories for alternating-current motors of wound-rotor or slip-ring types. Publication 500-A gives the list prices.

James G. Biddle, 1211-13 Arch Street, Philadelphia, Pa.—Pocket Manual 1060, "Concerning Insulation Testing with Special Reference to the Meg" is a 48-page book containing up-to-date data on the insulation of electrical apparatus, causes of breakdown, effects of moisture, surface leaks, temperature, etc. It describes the "Meg" and "Super-Meg" insulation testers (new instruments similar to "Megger" testing sets) and gives full directions for making "Meg" tests on practically all types of electrical apparatus. The manual is illustrated with charts and photographs.

Becker Brothers, Inc., 23 North Jefferson Street, Chicago, Ill.—A chart about 18 in. by 22 in., suitable for attaching to the wall for easy reference, is entitled "Physical Characteristics and Standard Qualities of Carbon, Graphite and Metal Brushes." The chart gives for each of the six groups of brushes, the general properties of that group and the following information on each grade: Mark, specific resistance, current density, co-efficient of friction, contact drop, hardness, breaking strength, peripheral speed, pressure recommended and a short recommendation for its use.

The Leather Belting Exchange, 119 South Fourth Street, Philadelphia, Pa.—This organization of belt manufacturers has had reprints made for distribution of the three articles by Robert W. Drake, Electrical Engineer, McCormick Works, International Harvester Company, on "When to Use Group and Individual Drives," which appeared in the Feb., Mar. and Apr. issues of INDUSTRIAL ENGINEER.

Grant Gear Works, 151 Pearl Street, Boston, Mass.—The new catalog and price list contains an unusually large amount of practical information on gears and gearings, such as: Drawing the standard involute tooth, drawing the spur gear wheel, drawing the bevel gear and bevel-gear tooth and a special bevel-gear chart as well as other necessary information for those interested in gearing.

Allen-Bradley Company, 491 Clinton Street, Milwaukee, Wis.—Bulletin 640 describes the Allen-Bradley Type H-1852, semi-automatic hand-operated, resistance starter. Simplicity of construction with every part readily accessible are some of the features claimed for it. Another feature claimed is that unless the operator starts the motor correctly, the contactor switch drops out and so protects the motor.

The Fuerst-Friedman Company, 1251-57 West Third Street, Cleveland, Ohio—Bulletin 27 lists in 40 pages the stock of the Fuerst-Friedman rebuilt, guaranteed motors and other electrical equipment, such as generators, motor-generator sets, plating generators, pulleys, rotary converterts, speed regulators, switches and transformers, as well as blowers and fans.

The Cincinnati Specialty Manufacturing Company, Inc., 1907-17 Powers Street, Cincinnati, Ohio—A folder describes the Autex automatic extension reel which has a swivel-joint feature permitting the lamp, drill or other equipment to be carried in any direction and an automatic lock permitting it to stop at any desired point. The insulation and connections have been given a test of 1,250 volts, although only 250 volts are required on lighting circuits by the Underwriters Laboratory, Chicago. This reel is made in two types provided with 25 or 50 ft. of extension cord.

B. A. Wesche Electric Company, Cincinnati, Ohio—A folder describes the Wesche Uniframe motors which are made in Type H, steel frame, direct-current motor and the Type N, squirrel-cage, alternating current motor in ratings from ¼ to 50 h.p. These motors have the same dimensions as to size of base, height from base to

center of shaft and top of frame, and other overall dimensions for the same horsepower and speed rating, which facilitates interchangeability of direct- or alternating-current motors in the assembly and connection to motor-driven apparatus.

William Ganschow Company, 1001 West Washington Boulevard, Chicago, Ill.—General Catalog 100, entitled "Handbook on Gears and Speed Transformers" contains over 300 pages divided into eight sections as follows: (1) Speed transformers, compound and worm gear speed reducers; (2) Cut spur gears and pinions, machine-finished racks; (3) Bevel, mitre and internal gears; (4) Worm gears and worms, worm hobs; (5) Spiral, spiral bevel, automotive, helical and double-helical gears, and miscellaneous machine products; (6) Bakelite Micarta pinions; (7) Rawhide gears and pinions; (8) Miscellaneous engineering data. Many tables, charts and other instructive material are included.

Cleveland Crane and Engineering Company, Wickliffe, Ohio—Catalog 3 offers a complete line of Cleveland electric tramrails and shows by illustrations a large number of applications of hoists and tramrails in practically all kinds of industries. Each illustration is accompanied by a short description of the application. A number of sketches are given showing methods of laying out switches and track and also devices for erecting tramrails.

Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.—Literature describes a new line of malleable iron, clamp structural pipe fittings designed for use with common wrought iron or steel pipe in the erection of outdoor or indoor electrical switching equipment. These malleable iron fittings can also be used for the construction of a variety of other work, such as racks, railings, benches or table frames, and with less difficulty than is encountered when ordinary pipe fittings are used.

Joslyn Manufacturing and Supply Company, 133 West Washington Street, Chicago, Ill.—Literature describes the McCollum electric hoists which are made in various sizes up to 5-ton capacity. These differ from the ordinary hoist construction in that there are no holding or lowering brakes employed. This is accomplished by means of an arrangement of speed reducing gears so mounted that they can be rotated only from the motor end and the load cannot cause the gears to rotate.

Western Electric Company, Inc., 100 East Forty-Second Street, New York, N. Y.—The Western Electric "Lighting Manual" discusses in simple terms the fundamentals of electric lighting and in addition describes representative systems of lighting available as well as offering suggestions to assist in selecting and applying those most appropriate and useful to commercial and industrial lighting systems.

Earl G. Trent, 1524 Chestnut Street, Philadelphia, Pa.—Leaflet T-A 2 describes and prices the Trent automatic control system for continuous service which not only indicates the temperature on a dial but controls the temperature by setting a lever to scale. Type 800 and 801 have a maximum range of 1,000 and 1,200 deg. F., respectively. Other types are made for a temperature from 100 up to 400 deg. This may be used for controlling electrically-heated devices, gas, steam, oil or air-heated appliances, for operating air or fuel valves independently or in conjunction, or for controlling the ratio of air and fuel valves and other uses.

Unit Costs of Lighting Systems

(Continued from page 332)

proper standpoint for him to think of lighting is in terms of his wage account, his payroll. It is not of any great consequence whether an installation costs $10,000 in a given space or $5,000, or $20,000. That is investment. The question is, what are the results he is going to get out of that investment by its use?

I have in mind one particular example where a lighting installation cost $6,000 in a portion of a building, and without any juggling of figures whatever it actually produced a 10 per cent saving in a $200,000 payroll, or $20,000 per year. I have no doubt that those of you who are also in the industrial field know of similar examples.

So I think that while we can cater to the prejudice of the man who must have his actual figures in dollars and cents, the thing we should do is to put the "soft pedal" on it just as far as we can, and present to him the lighting cost as a percentage of payroll. Of course, that will vary. For example, in the textile industry, in the weaving rooms where they use automatic looms, one operator may tend to twenty looms, and let the looms run for a half hour after the workmen are gone; the cost of light per operative is relatively high because every one of the twenty looms has to have exactly as good illumination as if attended by a single operator.

On the other hand, in many of the mechanical operations, as automatic screw machinery work in the automobile industry, where the operatives and machines are very close together, lighting is a very insignificant factor of the payroll.

But when all is said and done, lighting is an investment and its value is in labor and output and not in the cost of its operation.

JAMES M. KETCH: From the strictly commercial standpoint, I believe that the lighting problem will be simplified if both those who buy and those who sell come to think of lighting in the terms of unit cost.

Those who sell lighting or design it, know that the first thing asked of them is the cost. The difficulty of getting quotations on wiring costs and on lamp and reflector costs, will be very much simplified by a complete and comprehensive table worked up on the basis of unit costs.

CHARLES GALLO: Some of us who are called upon at times to design lighting installations have to give some attention to what reflecting equipment we shall recommend, and Mr. Tuck is to be congratulated on having given us at least the beginning of a method of comparison which, when it is properly standardized, will be easy, plain and simple to use.

Inasmuch as "general illumination" and "localized general illumination" are terms which do not always have the same meaning but which when applied under different conditions may mean different things, it would be well to test these various luminaires under identical conditions of spacing and of mounting height with respect to the working plane.

DAVIS H. TUCK: With regard to what Mr. Elliott said, one of the advantages of this unit system is to get the man's mind off the reflector that he is going to buy and to bring his mind down to the working plane and get him to think about what he is going to receive. In using this unit cost we say nothing about the reflector equipment or how it is going to be installed, what spacings or the size of lamp, or anything of that sort. We tell him we are going to give him a certain number of foot-candles on his work, on his machine, where his man is working.

Mr. Gallo seems to think that this was a test between competitive reflector equipment. It was not a test at all. We went into plants that we could get into and got the actual installation figures. We had to go into plants where we had the co-operation of the electrical contractor who installed the equipment so that we could get the cost figures.

This paper is written with the idea of introducing the practicability of the term "unit cost" in lighting and is not meant to be a comparison between the relative merits of various reflector equipment. Of course it is possible to obtain definite results with a wide variety of equipment. Under such wide variety of types of equipment, however, the unit cost of installation and maintenance will also vary widely.